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The Cost of Manufacturing Butter and Non-fat Milk Solids in Two Model plants in South Dakota

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THE COST OF MANUFACTURING BUTTER AND NON-FAT MILK SOLIDS IN TWO MODEL PLANTS IN SOUTH DAKOTA

BY

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THE COST OF MANUFACTURING BUTTER AND NON-FAT MILK SOLIDS

IN TWO MODEL PLANTS IN SOUTH DAKOTA

This thesis is approved as a creditable, independent investigation by a candidate for the degree, Doctor of Philosophy, and acceptable as meeting the thesis requirements for this degree; but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Representative, Graduate Faculty

Thesis Adviser

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CHAPTER I

INTRODUCTION

General

The dairying industry has undergone and will undergo evolutionary adjustments. Many changes have already taken place. This is evidenced by the change in the size of herds; the shifting from the sale of farm separated cream to the sale of whole milk; the improved methods of feeding; improved feeds and the changed system (adopted by many farmers) of purchasing feed requirements; the change in consumption trend; and finally, the system of marketing dairy products.[1] The changes started with World War I, when the prices of all products were soaring. These changes took the form of (1) variation in supply, (2) changes in the demand function for various commodities.

Nature of Supply

In recent years whole milk production in South Dakota has never approached the levels of thirty years ago, although recently, it has been exhibiting an uncertain rise. In 1959, South Dakota produced 1422 million pounds of whole milk from 274,000 milk cows.[2] This was a decrease of 15,000 in the number of cows below the 1958 level. The 1959

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[1] The Challenge of the Decade Ahead, Proceedings of the fourteenth annual midwest milk marketing conference, April 2 and 3, 1959, College of Agriculture at the University of Wisconsin.

[2] John C. Ranck, South Dakota Dairying, Crop and Livestock Reporting Service, 1959.

volume of whole milk produced was 70 per cent of the averaged 1926-1930 production. For the United States, there was a 28.9 per cent increase over the same period. The state's share of the nation's production declined from 2.1 per cent in 1926-1930 to 1.1 per cent in 1959. However, 87.1 per cent of the milk production in the state takes place in the eastern section. Thus, there were fewer cows per farm, and many producers, who slowly shifted from the sale of farm separated cream to the sale of whole milk.[3] At the start of the shifting there were many cream stations and a considerable number of creameries.

The trend toward the sale of whole milk and bulk assembly is evidenced by the decline of cream stations. In 1943 there were 626 such stations. By 1947 the licensed stations declined in number to 508. The downward trend continued until only 389 cream stations remained in 1951. There were 293 operating in 1957, and, finally, there were 219 such stations in 1959. Together there were 421 cream stations, creameries, and licensed dairy milk plants in South Dakota in 1957. The number of creameries, also fluctuated. In 1921 there were 101 licensed creameries. The number rose to 125 in 1936, then declined to 104 by 1943. After 1943, there was an upward swing to 113, but this trend was not long-lived. By 1951 they dropped to 96, then to 73 for 1957.

The Assembly Problem

The plants developed on a small scale due to transportation

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[3] T. W. Manning, R. Felberg, and R. L. Kristjanson, Milk or Cream, Agricultural Experiment Station, South Dakota State College, Brookings, Bulletin 460, February, 1957.

limitations.

There has been some easing of the transportation problem for the concentration of whole milk supply. The relief in the assembly of whole-milk was due to improved technology. The improvements came in the form of better highways, communication, refrigeration and methods of transportation. Thus, the advent of motor truck transportation, rapid communication, chains of better highways and farm bulk-milk coolers removed physical and economic limitations on the size of dairy plants.

As the automobile and the truck removed these limitations, territories of the different plants interpenetrated and overlapped. Distance from the central markets led the plants to specialize in butter rather than cream or whole milk.

As methods of production, assembly, and outlets changed, more frequent assembly was possible and necessary. Creameries and cream stations developed regular truck pick up routes. Earlier, two thirds of the milk producers sold to local creameries. Fifty per cent sold to cream stations during 1958.

The improvements in the channels of distribution have resulted in increased competition from both state and out-of-state firms. Some country plants are forced to operate on a smaller volume of whole milk at higher costs of production.

There are several causes for the maladjustment of small plants. They are: (1) changes in milk producing areas due to irrigation development and other regional production adjustments, (2) revision in spatial coverage, (3) vertical and horizontal integration, and (4) changes in governmental policies and programs.

Patrons' desire to maintain the small plants, in spite of the impact of changes in assembly and production, have permitted the maladjustment to continue. The reasons are: the required nature of investment, natural reaction against any change, the desire of managers to perpetuate their jobs, economic dependence of the communtities on employment provided by country plants and the desires of board members to retain some degree of control over distribution or marketing of their products.

Nature of Demand

South Dakota has become a surplus milk producing state.[4] Two-thirds of the milk goes into manufactured products or is consumed in other states or countries. The products manufactured are butter, cheese, powdered milk, condensed milk, buttermilk, ice cream, sherberts and ice-milk. Butter is produced from 88.2 per cent of the milk not needed for bottling; 4.4 per cent goes into American cheese; 2.7 per cent for cottage cheese, and ice cream and ice milk require another 4.7 per cent of whole milk. However, dairying is a minor part of the farming operation in South Dakota. Income from dairy products is 6 per cent of the total farm income. The major interest of the farmers is in other farm enterprises.

The rank of South Dakota in five dairy production categories is given in Table I. The state holds eleventh place in butter manufacturing and forty-first for the output of ice cream. At this level of production

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[4]Ranek, op. cit., p. 32.

TABLE I. SOUTH DAKOTA'S RANK IN NATIONAL PRODUCTION PROCESSES, 1958*

Commodity Produced	Rank Among States
Butter	11
American Cheese	21
Whole Milk	26
Cream and Cottage Cheese	32
Ice Cream	41

*Source: South Dakota Dairying, 1958

and with continuous pressure from other states, the economic position of the creameries in the state may become more precarious in the future. Many creameries in South Dakota operate on a volume of whole milk and/or cream that prohibits large scale economies. The resulting problem is a situation of cost-price squeeze that involves the assembly-distribution channel for whole milk and its products.

Chicago, New York, Boston, Philadelphia, Los Angeles and San Francisco held respective positions for market consumption of South Dakota's butter, with fifty per cent or more going to Chicago. The chief market, Chicago, absorbed 18,607,000 out of 23,794,000 pounds of butter in 1955, and 13,515,000 out of 16,407,000 pounds of butter marketed in 1957.

The consumption of butter has declined and resulted in a decreased need for cream or butterfat. The per capita consumption of dairy products, during selected years, is given in Table II. Between 1941 and 1957, fresh whole milk consumption increased, while butter consumption decreased fifty

TABLE II. PER CAPITA CONSUMPTION OF DAIRY PRODUCTS IN UNITED STATES FOR SPECIFIC YEARS[5] (In Pounds)

	1941	1945	1950	1955	1956	1957
Fresh Whole Milk	267	335	293	305	308	N.A.*
Cream	10.7	10.2	8.9	7.5	7.5	N.A.*
Condensed and Evaporated	18.5	18.3	20.1	16.2	15.9	15
Butter	16.1	10.9	10.7	9.0	8.7	8.5
Cheese	5.9	6.7	7.7	7.9	8.0	7.8
Cottage Cheese	2.0	3.0	3.5	4.5	4.9	N.A.*
Natural Buttermilk	40.4	34.2	28.7	26.8	26.7-	N.A.*
Nonfat Dry Milk	2.5	1.9	3.7	5.5	6.5	5.7
Ice Cream Products	13.5	15.7	17.2	18.0	18.0	17.9

*Data not available.

per cent, evaporated whole milk decreased three per cent and natural buttermilk consumption decreased 14 per cent. There was a thirty-three per cent increased consumption, during the same period, of American cheese. Cottage cheese and ice cream showed slight increases, while the consumption of nonfat dry milk increased from 2.5 pounds in 1941 to 5.7 pounds per capita in 1957.

Butter is the dominant product manufactured from surplus milk in the state and its by-product, skim milk, has an increased market demand

[5] Ranek, *op. cit.*, p. 29.

in the form of non-fat dry milk. It has shifted from the status of an almost waste product, in the production of butter, to the status of an important by-product. It is even possible that it may some day be the main product with butter assuming the lesser role.

In summary, the supply of whole milk has not shown much increase. The number of dairy cows has been decreasing, but there have been fewer low-producing dual-purpose animals in the state. Outlets for the raw resources have decreased in number and changed in kind. There is a gradual shift from the sale of farm separated cream to the sale of whole milk. Producers are involved in the overlapping of plants' assembly areas. Patrons, who are also producers, desire to maintain local plants. The competition between plants is keener due to improvements in the channels of distribution and assembly. There has been a decrease in the consumption of most dairy products, but two thirds of the whole milk produced in the state is either sold in non-state regions or manufactured into dairy products. These and other factors have affected the outlook of the producers toward the industry.

The changes in technology on the supply side, and in consumption patterns on the demand side have had a great impact on the operation of butter and dry milk manufacturing plants. The adjustments have been slow in coming--the lack of knowledge as to costs and alternatives may have been an impediment.

Some efforts have been made to attack the problem of inadequate information. Most of the studies throw light on the costs of plants of a size appropriate to South Dakota conditions. A review of some of the research concerned with one or more phases of production follows.

Review of Literature

One of the earliest efficiency studies of the dairy industry was made in 1942.[6] This study employed budgeting analysis of the efficiency of operation as the research procedure. The objectives were (1) the determination of plant costs under efficient operating conditions, and (2) the development of descriptions of economies of scale for any type of plant that may be used in more efficient marketing organizations. It was believed that this kind of analysis might be the practical means of describing the efficient level of costs for the operation in question. A sample of eight fluid milk plants, that represented a range in volume and capacities, was studied. In each plant, the relationship of changing volume on variable input was considered. The variable inputs considered were costs of electricity for fuel and lighting, coal for power, and labor. Postage, office supplies, telephone and telegraph outlay were classified as secondary costs. Fixed costs analyzed were plant and equipment. The unit cost data computed were used to (1) develop cost curves, and (2) lay out model plants for different volumes of inputs. The resulting variable cost curve was horizontal and the fixed cost curve fell continuously; the labor input cost curve rose in "jerks"; and

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[6] R. G. Bressler, Jr., Economies of Scale in the Operation of Country Milk Plants, Boston, Massachusetts, 1942.

finally, the average cost curve declined rapidly, then tended to level out as volume increased. In the eight plants studied, the volume of milk assembled increased as the receiving period was extended. However, the cost curve fell for time-receiving periods of 2½ to 3½ hours in length. Beyond this time span the curve rose rapidly. The conclusion was reached that considerable saving would result from the elimination of plant duplication and uneconomical plants.

An Economic Analysis of Butter-nonfat Dry-Milk plants was made at the University of Idaho in 1953.[7] This was a regional dairy marketing report. The objectives of this Western Regional Research Project were to: (1) assemble economic information useful to managers of butter manufacturing plants, (2) determine the relationships of resources in specialized butter-powder plants for various scales of operations and efficiencies, (3) determine physical and monetary costs of manufacturing butter and dry-milk solids, and (4) develop costs standards for measuring efficiencies and making decisions. To make this type of study, twelve plants located in Washington, Oregon and Idaho were selected and intensively analyzed for seventeen manufacturing functions. Based on the information obtained on volume-cost relationship, the detailed plans of model butter-powder plants were developed--they were designed to be used as "standards of efficiency" in nonfat dry-milk and butter production. Generally, there were three conclusions drawn from the results of this research: (1) that

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[7]S. H. Walker, H. J. Preston, and G. T. Nelson, An Economic Analysis of Butter-nonfat Dry-Milk Plants, Bulletin Number 20, University of Idaho, 1953.

plant efficiency increases as the volume of processed milk increases up to the assumed plant capacity. (Here, capacity is an industrial concept and not an absolute technical determination). (2) As the scale of operations increased, the unit costs of products declined — the larger the plant volume, the smaller is the cost per unit of output. Butter-powder production is a decreasing cost industry. (3) That incentives exist for managers of dairy products manufacturing plants, to extend operations due to decreasing average, marginal and per unit costs of outputs. For these reasons the long run industrial outlook is for (a) increased concentration, and (b) larger plants.

The cost of manufacturing butter was a research project study at Iowa State College in 1952.[8] Involved in this study were thirteen co-operative creameries in Iowa. Fraser, Nielson and Nord observed that there are "three distinct cost phases" in the manufacturing of butter. They concluded that "the first phase, for volumes up to 700,000 pounds, was one of rapidly decreasing unit costs. The second phase, for volumes ranging from 700,000 to 1,500,000 pounds, was one of essentially constant unit costs, with an indication of somewhat higher costs in this area. The third phase, for volumes above 1,500,000 pounds, was one of slowly decreasing unit costs. The largest volume studied was 3,000,000 pounds of butter annually, and at this volume, costs were 1/2 to 3/4 cent less than for plants producing 700,000 pounds. This represents a decrease in unit costs of approximately 15 per cent".

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[8] J. R. Fraser, V. H. Nielson, and J. D. Nord, The Cost of Manufacturing Butter, Agricultural Experiment Station, Iowa State College, Ames, Iowa, Bulletin 389, June, 1952.

An analysis of processing cost, in specialized butter plants receiving whole milk, was made.[9] This study had two main objectives: (1) estimate a planning curve for specialized butter plants receiving whole milk and (2) compare the effects of can and bulk milk receiving on specialized butter plant cost. In general, the shape of the planning curve of the specialized butter plants was to be determined. It was hypothesized that the study would determine the cost-volume relationship in specialized butter plants receiving whole milk. The procedure used was to analyze and record the production processes, determine various techniques used in each stage of the production process, standardize factor prices, and develop total cost functions for a plant from numerous short run average cost curves involving a wide range of volumes. Three sample plants were selected from the 18 surveyed plants, as the basis of the study. The result from achieving the objectives showed economies associated with increased sizes for all cost functions; that cost curves turned upward when volume was greater than "physical capacity"; and that the saving in cost due to larger volume was greater than the economies associated with increasing the size of the plant.

Research on models was made by Linley E. Juers. This research project had a three-fold objective:[10] (1) present a framework for analysis of costs in both fixed and variable proportion plants, (2) derive

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[9] A. C. Kundtson, An Analysis of Processing Cost in Specialized Butter Plants Receiving Whole Milk, University of Minnesota, 1957.

[10] Linley E. Juers, Unpublished Ph.D. Thesis, Department of Agricultural Economics, University of Minnesota, 1957.

short run cost functions for butter-powder plants, and (3) describe the problem and limitations of such cost analysis. These three objectives were to be accomplished with synthetic models, information obtained from audit reports, observation of several different plant procedures and through talks with plant managers. Plant samples were selected on the basis of plant capacity and fixed-proportion output. Because of differences in plant operation and managerial policies, data taken from plant records were not used. Instead, the synthetic method of costing was found to be advantageous. The conclusion was that economies of scale are to be found in butter-powder plant operation: this could be brought about by (1) using larger size equipment, or (2) the addition of similar size units of equipment. Only a linear relationship was found to exist between the input and output data. It was also noted that variations in outputs are associated with the length of operating time and not variations in the output rate per unit of time.

Justification for the Study

Several of the problems of small manufacturing plants have been considered in the literature reviewed. Results of the research projects were that the elimination of plant duplication and uneconomical plants would result in savings; that the long run trend in dairy plants was increased concentration and larger plants; that cost differentials were related to time and spatial factors of operation; that economies are associated with increased sizes for all cost functions, and that economies of scale are to be found in butter-powder plant operation.

The research revealed: that vertical and horizontal integration have gained impetus, that tremendous improvements in machinery have been made, that cost of construction has risen; that labor is more efficient, due to technological advances; that inputs cost more than in the previous decade, and that there are many changes in the methods of assembly of the raw resources input and distribution or marketing of the finished products of the dairy industry.

The studies that have been made have not shown the savings that will accrue to a plant, the change in cost of specific factor inputs, the nature of changes in equipment nor the increased financial outlay required for plant and equipment should a "going plant" receive all of the whole milk produced in its assembly area.

In view of the fact that presently some plants have been discussing the feasibility of merging, this research appeared timely and vital to the South Dakota Dairy Industry.

Hypothesis

It is hypothesized that South Dakota dairy plants can operate at lower unit manufacturing cost by small plant mergers to increase volume so that labor, modern technology and other inputs into the consolidated plants could be used more efficiently.

Objectives and Scope

The primary purpose of this research was to provide data that can be used in decision making regarding the more profitable operation of dairy manufacturing plants.

In addition, this study is to develop economic information needed by managers of dairy plants to adjust plant operations to changes required for economies of production, and lowering costs of processing. This is to be attained by varied methods: (1) synthesize costs of model butter and dry milk manufacturing plants, (2) ascertain efficiency with which fixed and variable inputs can be operated at a special level of output, (3) determine the physical requirements and monetary costs of manufactured butter and dry milk at the stated quantity, and (4) develop cost standards for each phase and function of operation at a more efficient level as a basis for decision making on whether merger of butter and dry milk manufacturing of present creameries is profitable.

Two synthetic models are to be developed that will allow for the individualized treatment of the factor inputs. Also, they will permit an analysis of economies of plant size and comparisons of inter-departmental operations. This method of analysis allows for a departmental functional approach to the manufacturing problems and, also, considers the institutional factors of decision making. The cost data developed will be based on "in the plant" processing.

A long range goal of any firm is usually the establishing of a plant which has the highest practical efficiency within the limitations of the situation. The plant design and the manufacturing costs data developed in this research project can be used as guides or standards for achieving that goal. This research points out the efficiency that can be obtained by the improved organization of labor and other factors, the use of modern equipment, and the reduction of unit costs through larger volumes of production.

The technical efficiency with which this research is concerned has an economic implication that is positive in character for the producer-patrons. A creamery that assembles all the whole milk produced in a particular area can reduce its per unit cost of operation and lower its per unit cost of assembly. Such a plant will be in a better financial position either to pay more for the raw whole milk input purchased from the farmers or return to them a larger patronage dividend if the plant is a cooperative. Also, the creamery may be in a position to render more and improved services, as well as meet competition for the resources produced in its assembly area.

Procedure

Technical assistance was secured from persons in the field of dairy engineering for the purpose of setting up hypothetical model butter and dry milk manufacturing plants of two sizes with normal daily capacities of 100,000 pounds and 160,000 pounds of whole milk.

Consideration was given to the following aspects of butter and dry milk manufacturing: the size and construction of the building and facilities; the quantity and specifications of equipment; labor inputs required to operate various functions of the plant; costs of certain inputs, such as labor, utilities, rents, interest, insurance, and supplies; the estimated time required and cost of each phase and operational function; and, finally, the cost of fixed inputs, building and equipment.

CHAPTER II

MODEL SELECTION AND PLANNING

General

There is much overlapping of the assembly area of creameries. Previous research on the subject of overlapping of procurement areas has shown that in certain sections of the state as many as five creameries or centralizers gather whole milk and/or cream.[11] From some areas as few as two creameries assemble the product. From no large area did only one manufacturer or dairy procure whole milk and/or cream. This overlapping of assembly routes causes higher trucking costs.

If a dairy manufacturing plant was to receive all of the whole milk offered for sale, except the amount used for bottling purposes from its present procurement area, its volume could be increased.[12] It appeared that this could be accomplished without increasing unit hauling costs. However, even though the per unit hauling cost may not be higher (possibly even lower) the total cost may increase since there might be additional fixed outlay for rolling stock and more drivers, or overtime pay for persons presently employed.

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[11] T. W. Manning, R. Felberg, and R. L. Kristjanson, Milk or Cream, Agricultural Experiment Station Bulletin 460, South Dakota State College, Brookings, S. Dak., 1957.

[12] The reallocation of procurement territories among all existing plants, in order to avoid costly duplication of routes, would not increase the volume of any one plant except at the expense of the other plants. It is assumed that consolidation, merger, or some other means of removal of smaller and more inefficient plants must, and will occur.

Increased volume rising from consolidation will change unit manufacturing costs. To determine the amount and direction of the change, two different size plant models were developed. The function of each plant was to manufacture both butter and non-fat powder-milk. For convenience, the models are referred to as Plant A and Plant B. For these plants, per unit costs were developed.

For purposes of determining the actual supply of whole milk available in a definite geographical area in South Dakota, and as a rough check on the cost figures attained, an actual operating plant in eastern South Dakota was selected as a case plant. The procurement area of this plant was ascertained through consultation with the route supervisor of the plant. The present volume of 100,000 pounds of whole milk was the calculated averaged daily input of this reference plant. Model plant A was designed to handle the 1958 volume of the reference plant.

There was a possible daily volume of 171,918 pounds of whole milk that could be procured from the reference plant total procurement area during the year 1958. This full potential volume was not received by the case plant since other plants serviced portions of the same area. Some of the volume was sold to other dairies as Grade A milk or as farm separated cream. Thus, the larger model, plant B, was based on a possible averaged daily volume of 160,000 pounds of whole milk. The assumption was that Plant B would receive all the supply of the area, except the Grade A.

Both of the volumes would be considered small in other areas. In estimating future volumes consideration must be given to such factors as seasonal fluctuation in production and the increasing size of herds. Also important is the fact that production per cow is increasing. Therefore, the future volume may be even larger than at present.

Further, the assumption was that once the costs have been calculated for the model plants by factor inputs, a production type of equation would be difficult to formulate. The use of such equations would not enable a plant manager to obtain reliable cost data for varied aspects of inputs as the daily volume increases or decreases, within the capacity level.

This does not solve the problem of estimating costs for plants of larger capacity such as might be needed in the longer run. These, however, have been provided in other studies previously cited (13) and here attention has been concentrated on the gap in the data provided by such studies.

In the models we are dealing with averages, since actual receipts may range from twenty per cent above average, to the same percentage below average. The plants are designed to accommodate the contemplated peaks. This means that much of the time there is excess capacity.

Admittedly, it is difficult to find the lowest cost point for this "industry" in the long run. Emphasis is on individual plant efficiency to reduce cost. This can take place as the inputs exceed the average, or vice versa. Thus, we have in mind the end of stage one output, or where the short run cost is lowest. That is where the marginal physical product cost equals the marginal revenue, or the average variable cost equals the marginal cost. This output point should not be confused with the output level where Marginal cost equals Marginal revenue. They may not be the same input-output point of the expansion path.

Pilot Area Selection

Choosing the territory that is under consideration did not require any specific criterion that would not be applicable to any other area. The only requirement was that the procurement area of a particular plant should be selected. This would make reality a significant feature of the data, since the actual volume of the plant could be ascertained, as well as the potential volume.

The plant selected assembled its raw resource input, whole milk, from a six county area. The involved counties and their production per square mile for the years 1957 and 1958 are given in Table III. The area of each county ranged from a low of 520 to a high of 819 square miles. Whole milk production in the same area ranged from a low of 27,960 pounds to a high of 74,780 pounds for each square mile in 1958.

The pounds of whole milk produced per square mile in each county was applied to the square miles covered by the case plant in that county. The result was a potential assembly volume of 57,856,429 pounds of whole milk for the year ending in June 1957 and 62,750,400 pounds for the 1958 period. The two total volumes are shown by counties in Table IV.

The actual volume assembled by the case plant was 26,038,991 pounds

TABLE III. MILK PRODUCTION PER SQUARE MILE FOR COUNTIES SERVICED BY THE CASE PLANT IN SOUTH DAKOTA, 1957-1958

Counties Serviced	Square Mile Per County*	Milk Production** 1957	1958	Pounds Produced Per Square Mile 1957	1958
		(000)			
Lake	571	31,800	23,900	55.69	59.369
Moody	523	31,270	32,500	59.79	62.14
Kingsbury	819	23,460	22,900	28.64	27.96
Hamlin	520	30,090	31,300	57.865	60.19
Deuel	636	43,500	44,000	68.396	69.18
Brookings	801	57,240	59,900	71.46	74.78

*From 1950 United States Census

** South Dakota Dairying, June 1958, South Dakota Crop and Livestock Reporting Service.

of whole milk in 1957, and 36,545,229 pounds in 1958. Other area dairies purchased 3,822,266 pounds as Grade A milk in 1957 and 3,985,490 pounds in 1958. Of the ~~balance~~ produced in the area, 1,941,485 pounds in 1957 and 2,184,971 pounds in 1958 were sold as farm separated cream. Also, there were 27,995,172 pounds in 1957 and 22,219,681 pounds in 1958 that were either sold to other creameries or consumed on the farms. Therefore, the potential volume shown in Table IV is based on the assumption that there is little or no milk consumed on the farm and that all whole milk which is not sold as grade A milk will be sold for manufacturing purposes.

TABLE IV. POTENTIAL ASSEMBLY VOLUME FOR CASE CREAMERY, 1957 - 1958

Counties	Square Miles Covered	Pounds Produced Per Square Mile		Potential Assembly Volume	
		1957	1958	1957	1958
		(000)			
Lake	3.5	55.69	59.369	194.915	207.79
Moody	15.5	59.79	62.14	929.745	963.17
Kingsbury	1.0	28.64	27.96	28.64	27.96
Hamlin	26.5	57.865	60.19	1533.423	1595.04
Deuel	139.0	68.396	69.18	9506.766	9616.02
Brookings	639.0	71.46	74.78	45,662.94	50,340.42
Totals	824.5			57,856.429	62,750.40

Planning for the Building and Equipment

General Assumptions

The model plant study necessitated that there should be many assumptions. Without them it would be impossible to equate the efficiency of operation for the two model plants. The varied assumptions follow:

(1) The raw resource input is whole milk with an average of 3.5 per cent of butterfat.

(2) All costs are related to, and based on the average daily receipts of whole milk.

(3) Seasonal patterns are not significant.

(4) Cream used in butter production is 40 per cent concentrates (Butterfat).

(5) The per unit hauling cost is the same for both plants, therefore, they are not considered in this research.

(6) Butter contains 2 per cent salt, and is packaged in 64 pound bulk units.

(7) Plant buildings for the two volumes are the same size and constructed of similar materials and design.

(8) Similar equipment and technique are employed. The capacity of some equipment varies.

(9) All utilities are to be purchased from other sources.

(10) Office staff (excluding the manager) is employed on a 44-hour week. Plant workers are hired by the hour for a minimum of 40 hours per week.

(11) Plants are to operate on a seven-day week schedule.

(12) All work can be performed within the scheduled time.

(13) Pay scale for employees is based on the prevailing community rate.

(14) Managerial position is purely supervisory.

(15) The boiler operation is 75 per cent efficient.

(16) Legal moisture content of powder-milk is 3.5 per cent.

The above general assumptions are designed to give similarity of performance and operation to the two model plants.

Building Plan

The building is considered to be constructed of concrete block walls, the floors and foundation are of reinforced concrete. The processing room has tile six feet high covering its walls; and the roof is constructed of materials required for climatic need. The general shape and areas of the building are shown in Figure 1. The idea was to eliminate all excess space, while providing adequate area to promote efficiency and ease of operation.

PLANT LAYOUT OF A MODEL BUTTER-POWDER MANUFACTURING PLANT

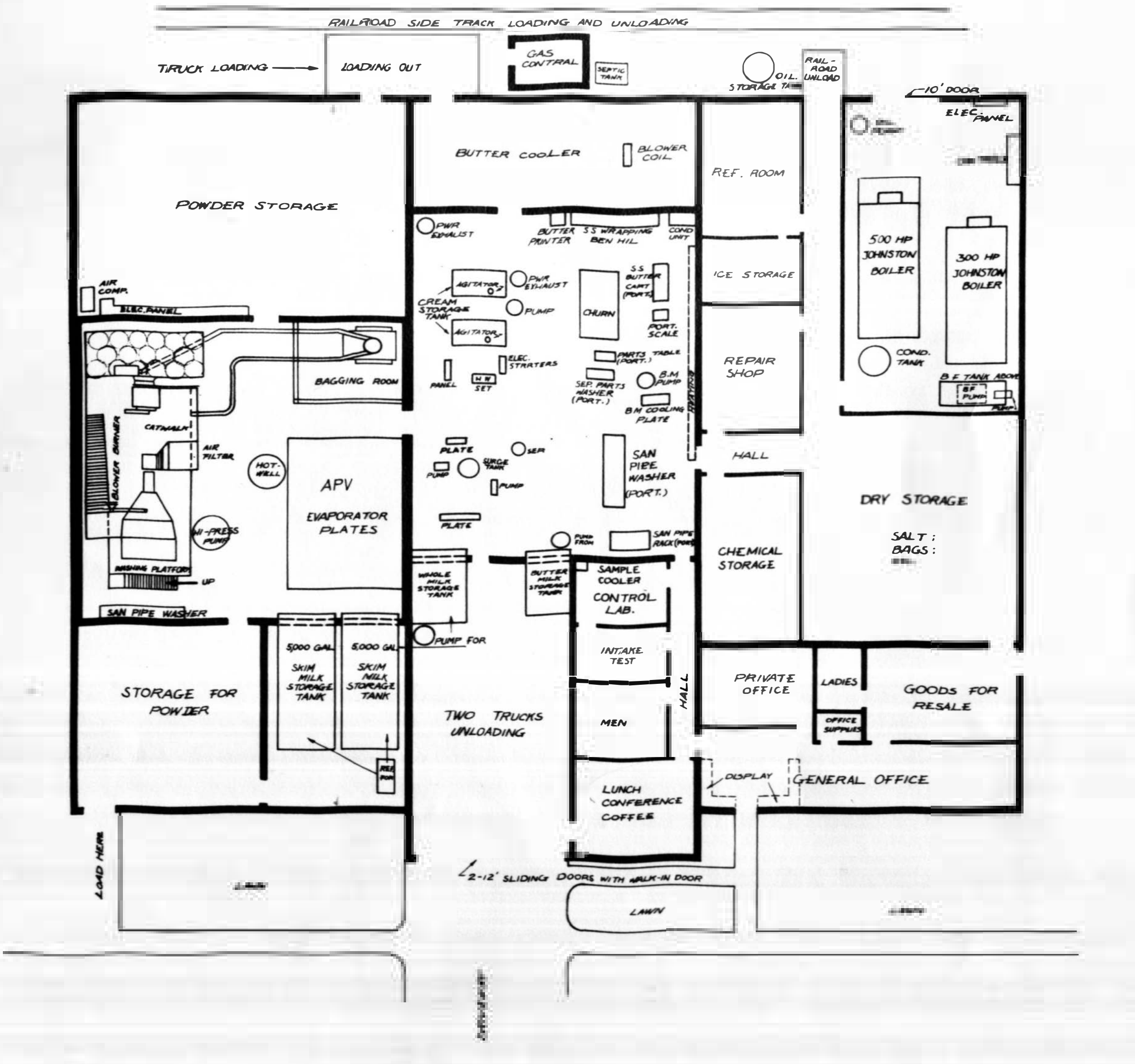

FIGURE - I

1:16

The building is divided into sections. They are:

A. Evaporation and dry milk storage area.

B. Receiving and processing area for whole milk, and butter manufacture and storage.

C. General service area. This includes the offices, boiler room, repair shop, refrigeration room, hall ways, space for chemical and general storage, rest rooms, and an area that may be used for resale items.

The plan was drawn in a manner which allowed 5616.5 square feet of floor space for section A; an area of 5,028.46 square feet for section B; and section C required the balance of the 15,632.32 square feet of floor space in the building. The detail of the break down is given in Table V.

However, it should be noted that the building is the same size for both sizes of the models. The reason for this is that the change in the quantity of input can be efficiently handled by changing the capacity of certain pieces of equipment, which will occupy a very little increase, if any, in floor space.

The medium anticipated cost for the building construction is assumed to be 14 dollars per square foot. There has been a low area cost of nine dollars per square foot where there were only the four outside walls. The highest known allocation is 16 dollars per square foot — the more inside walls there are, the higher is the cost per square foot. These cost data were secured from local contractors.

Equipment Layout and Planning

The equipment for plants A and B is listed in Tables VI and VII.

TABLE V. BUILDING COST FOR PLANTS A AND B AND PERCENTAGE OF SPACE BY AREAS

Areas	Dimensions in feet	Square Foot Area	Cost Per Square Foot	Total Cost	Per Cent of the Total Area
Powder-milk Production areas—					
(1) Powder-milk storage	50 X 34 2/3	1733			
(2) Evaporation	50 X 48	2400			
(3) Powder-milk storage	50 X 29 2/3	1483.5			
Sub-total		5615.5	$14.00	$78,631.00	35.93
Bulk handling area					
(1) For trucks unloading	24 X 48 (7 1/3 X 8 1/2) plus (8 X 10)	1009.7			
Sub-total		1009.7	$14.00	$14,135.80	6.46
Butter Production					
Tank space	(7 1/3 X 8 1/2) plus (8 X 10)	142.3			
Butter cooler	44 X 16.8	740.52			
Separating-churning	(44 X 54. 1/2)	2398.00			
Ice and Refrigeration	15 X 32	480.00			
Control and Test Laboratories	14 1/3 X 18	257.94			
Sub-total		4,018.76	$14.00	$56,262.64	25.71
Chemical Storage	27 X 15	450.00	$14.00	$5,670.00	2.99
Dry Storage	33 2/3 X 32 1/3	1,250.20	$14.00	$17,502.80	8.00
Goods for Resale	22 2/3 X 15	339.90	$14.00	$4,758.60	2.17
Boiler room	26 X 48	1,170.00	$14.00	$16,380.00	7.48
Repair shop	15 X 20	300.00	$14.00	$4,200.00	1.92

Continuation of Table V.

Areas	Dimensions in feet	Square Foot Area	Cost Per Square Foot	Total Cost	Per Cent of the Total Area
Administrative					
Rest room (men)	12 X 14 1/3	172.00			
Rest room (women)	10 X 7	70.00			
Private office	17 X 12 1/2	212.50			
General office	48 X 10 1/2				
	plus				
	17 X 2 1/2				
	plus				
	7 X 4 1/3	576.81			
Halls	4 X 31 2/3				
	plus				
	48 1/3 X 5 2/3				
	plus				
	15 X 6	490.95			
Sub-total		1,522.26			
Totals		15,632.32	$14.00	$218,852.48	100

Facilities are grouped by areas of function. The capacity of the pieces of equipment was chosen with synchronization of machinery, in sections A and B, as a goal. This system of operation would eliminate the use of regenerative heat and reduce the consumption of oil, gas and electricity.

The boiler room includes the boilers that are completely automatic for heavy oil (number 4 or 5), oil tanks, condensate tank and pump (boiler feed water) and a blow off chest. The cost includes delivery and installation, but not plumbing.

Refrigeration includes a sweet water tank, ammonia compressor with evaporator condenser for cooling and condensing ammonia and sweet water pumps. The cost covers delivery and installations, except for plumbing to creamery equipment. All plumbing costs are included separately with each area compilation of input factors.

TABLE VI. PLANT A - EQUIPMENT COST AND QUANTITY BY AREAS

Equipment by Production Areas	Quantity	Gallon Volume	Unit Cost	Total Cost	Per Cent of Total
Powder Milk Production					
Skim milk storage tanks	2	5000	$6044.	$12088.	
Pump-2 engine	1		450.	450.	
Refrigeration unit	1		7000.	7000.	
Sanitary Pipe Washer	1		896.	896.	
Spray dryer	1		55000.	55000.	
APV evaporator plates	1		60000.	60000.	
Electric wiring				2000.	
Plumbing for steam, water, refrigeration				2000.	
Sanitary tubing, valves, fittings, etc.				4000.	
Sub-total				$143434.	48.14
Butter Production					
SS wrapping machine (Ben Hil)	1		13825.	$13825.	
Laboratory equipment			6000.	6000.	
Pump-2 engine	1		450.	450.	
Whole milk storage tank	1	3000	4689.	4689.	
Buttermilk storage tank	1	2000	3861.	3861.	
Sanitary Pipe washer	1		896.	896.	
Separate parts washer	1		1777.	1777.	
Parts table	1		428.	428.	
Scale	1		680.	680.	
SS butter cart	1		3600.	3600.	
Separator HTST plate	1		6350.	6350.	
Pump	1		503.	503.	
H.W. Set (Cream post)	1		7955.	7955.	
18000# SS separator	1		6170.	6170.	
B.M. cooling plate (14000# hr.)	1		1985.	1985.	
B.M. pump 1 1/2 eg.	1		360.	360.	
Churn	1		12750.	12750.	
Cream storage tanks	1	2000	3861.	3861.	
Pump-2 engine	1		450.	450.	
Electric wiring				3000.	
Plumbing for steam, water, etc.				2500.	
Sanitary tubing, valves, etc.				6000.	

Table VI. continued

Equipment	Quantity	Gallon Volume	Unit Cost	Total Cost	Per Cent of Total
(Bulk unloading)					
Spray ball unit	1		175.	175.	
Spray ball work pump	1		538.	538.	
Milk pump 2-engine	1		450.	450.	
SS wash sink	1		75.	75.	
SS surge tank	1		1000.	1000.	
Refrigeration and Ice Unit					
17,500# 30# compressor	1		10000.	10000.	
Sub-total				$100328.	33.67
Tool room tools—equipment				$1000.	
Sub-total				$1000.	0.34
Boiler room					
500 HP boiler installed			26616.	$26616.	
300 HP boiler installed			21000.	21000.	
Plumbing leading out				500.	
Sub-total				$48116.	16.13
Administrative					
Executive desks	2		150.	$ 300.	
Typist desks	2		160.	320.	
Small safe	1		300.	300.	
Metal file cabinet	2		70.	140.	
Printing calculating machine	1		455.	455.	
Manual typewriter	1		250.	250.	
Executive chair	1		45.	45.	
Typist chair	1		35.	35.	
Straight wood chairs	4		20.	80.	
Folding chairs - metal	50		5.	250.	
Miscellaneous				300.	
Hoist and pallets	1		2500.	2500.	
Sub-total				$5055.	1.7
Total Equipment Cost				$297933.	100.

TABLE VII. PLANT B - EQUIPMENT COST AND QUANTITY BY AREAS

Equipment by Production Areas	Quantity	Gallon Volume	Unit Cost	Total Cost	Per Cent
Powder Milk Production					
Skim-milk storage tanks	2	6000	$6920.	$13840.	
Pump-2 engine	1		450.	450.	
Refrigeration unit	1		7000.	7000.	
Sanitary Pipe Washer	1		896.	896.	
Spray dryer	1		75000.	75000.	
APV evaporator plates			75000.	75000.	
Electric wiring				2000.	
Plumbing for steam, water, refrigeration				2000.	
Sanitary tubing, valves, fittings, etc.				4000.	
Sub-Total				$180186.	51.88
Butter Production					
SS wrapping machine (Ben Hil)	1		13825.	$13825.	
Laboratory equipment				6000.	
Pump 2 engine	1		450.	450.	
Whole milk storage tank	1	5000	6044.	6044.	
Buttermilk storage tank	1	3000	4689.	4689.	
Sanitary pipe washer	1		896.	896.	
Separate parts washer	1		1777.	1777.	
Parts table	1		428.	428.	
Scale	1		680.	680.	
SS butter cart	1		3700.	3700.	
Separator HTST plate	1		7380.	7380.	
Pump	1		503.	503.	
H.W. Set (cream pasteurizer)	1		8780.	8780.	
25000# SS separator and starter	1		9315.	9315.	
B.M. cooling plate (14000# hr.)	1		1985.	1985.	
B.M. pump-1 1/2 engine	1		360.	360.	
Churn	1		14250.	14250.	
Cream storage tank	1	3000	4689.	4689.	
Pump 2 engine	1		450.	450.	
Electric wiring				3000.	
Plumbing for steam, water, etc.				2500.	
Sanitary tubing, valves, etc.				6000.	
(Bulk unloading) Spray ball unit	1		175.	175.	

Table VII. continued

Equipment	Quantity	Gallon Volume	Unit Cost	Total Cost	Per Cent
Spray ball work pump	1		538.	538.	
Milk pump, 2 engine	1		450.	450.	
SS wash sink	1		75.	75.	
SS surge tank	1		1000.	1000.	
Refrigeration and Ice Unit	1			13000.	
Sub-total				$112939.	32.52
Tool room tools - equipment				$1000.	
Sub-total				$1000.	.29
Boiler room					
500 HP boiler				$26616.	
300 HP boiler				21000.	
Plumbing leading out				500.	
Sub-total				$48116.	13.85
Administrative					
Executive desks	2		150.	300.	
Typist desks	2		160.	320.	
Small safe	1		300.	300.	
Metal file cabinet--lock	2		70.	140.	
Printing calculating machine	1		455.	455.	
Manual typewriter	1		250.	250.	
Executive chairs	2		45.	90.	
Typist chairs	2		35.	70.	
Straight wood chairs	4		20.	80.	
Folding chairs - metal	50		5.	250.	
Miscellaneous				300.	
Hoist and pallets	1		2500.	$2500.	
Sub-total				$5055.	1.46
Total Equipment Cost				$347296.	100.

In the bulk tank unloading room are to be found the C.I.P. cleaning equipment for the truck tanks and unloading pumps. The two engine pumps are designed to unload the truck tanks at the rate of 100 gallons per minute.

The processing room is complete except for hand tools. There is a 900-gallon churn for plant A and an 1100-gallon churn for the larger plant B. There are two sizes of pasteurizing equipment which is HTST complete with cream going into the storage tanks and buttermilk into the BM tank headed into the processing area. The plate coolers are equipped to cool skim milk that does not go directly into the evaporator. They are large enough to cool all of the skim milk, should the evaporator be shut down.

A Benhil butter printer is included as a part of the processing equipment. It will print soft butter, direct from the churn, at a rate of thirty-five pounds per minute -- in one pound units, and in quarters at the same rate. There are two butter boats for each churn. The churn and butter boats are constructed of aluminum alloy.

The separator parts washer is a Schluter circulating make. It may be used as a CIP circulating pump powered by a 10 horse-power motor. There is also a sanitary pipe washer. It is a Schluter SS tank equipped with a motorized brush. The HTST plates include two seperate plate heat exchangers. One is used to pre-heat whole milk for the separators. The other cools skim milk. This is eighty per cent regeneration with the final cooling being done with sweet water to a thirty-eight degree temperature. The other plate is used for the pasteurization of the cream HTST--to a temperature of one hundred ninety or two hundred degrees, then cooled to forty degrees with water or sweet water.

The evaporating area has the APV Plate evaporator. This is the latest in design of evaporators. There is only one in use in the United States. The capacity can be increased to 42,000 pounds per hour by the addition of plates. The ease with which it can be cleaned saves time and money. In addition, there are two storage tanks for skim milk headed into this area. They are provided for storage in case of a shut down, or should skim milk be purchased from other creameries in order to use more fully the fixed inputs on an around-the-clock basis.

The drying section is fully equipped. Gas is the source of required heat. Had it been designed to use another type of fuel, larger boilers would be necessary and the cost would be greater.

Boilers that burn heavy oil are used in the boiler room because:

(1) Oil and gas burners cost about the same.

(2) Auxiliary oil burners are necessary with gas burners. The reason is that there may be low gas pressure or some other fault during operation.

The difference in equipment cost for the two plants can easily be compared on a percentage basis. While the raw resource input is, on the average, sixty per cent greater in plant B over plant A, the equipment cost for plant B is only 16.57 per cent greater. The equipment inputs cost had its greatest increase in the evaporating room or section A. The positive change equalled 3.74 per cent. In all of the other functional areas the change was negative. The tabulations are given in Table VIII. The negative values shown in this table do not imply that there was a decrease in the total cost of equipment for four of the five functional areas. They do mean, however, that when cost of equipment is related to the increased input of whole milk by plant B, the relative change of factors was negative -- that is, the increase in quantity was greater percentage-wise than the increase in cost. Also, a comparison of total equipment cost was made, as is shown in Table IX. Cost of equipment increased in two of the five areas. The largest increase was found in dry milk output. It was 36,752 dollars or 25.62 per cent of the cost for plant A. The overall increase in equipment cost was 16.57 per cent or 49.363 dollars. Thus, by increasing fixed cost inputs only 16.57 per cent, a firm can handle a sixty per cent larger volume. This is a percentage ratio of 1 to 3.62.

TABLE VIII. EQUIPMENT COST AS A PERCENTAGE OF TOTAL BY AREAS

Areas	Plant A	Plant B	Change
Powder milk	48.14	51.88	3.74
Butter	33.67	32.52	-1.15
Tool room	.34	.29	- .05
Boiler room	16.15	13.85	-2.30
Administrative	1.70	1.46	- .24
Totals	100	100	000

NOTE: Equipment cost increased 16.57 per cent above plant A with input of raw resource increasing by sixty per cent.

TABLE IX. COMPARATIVE TOTAL EQUIPMENT COST BY AREAS
(Plants A and B)

Areas	Plant A Total Cost	Plant B Total Cost	Excess of B over A Amount	Excess of B over A Percentage
Powder milk	$143,434	$180,186	$36,752	25.62 plus
Butter Production	100,328	112,939	12,611	12.57
Tool room	1,000	1,000		
Boiler room	48,116	48,116		
Administration	5,055	5,055	------	
Totals	$ 297,933	$347,296	$49,363	16.57

CHAPTER III

INSURANCE, INTEREST, PROPERTY TAXES, MAINTENANCE COST, AND DEPRECIATION

Insurance Cost

General

The consideration of insurance covers the two model plant buildings, the equipment contents, social security, and workers liability and compensation. Since it is not possible to ascertain the quantity or value of the finished or semi-finished products and raw resource input that will be on hand at any given time, this insurance cost was not calculated. The charges in the different categories are basically the results of the area and local community rates.

Fire Insurance

This insurance cost, fire and extended coverage, was based on the rates for a masonry type of structure for the plant buildings, and the fixed equipment or fixed input contents. The cost of the buildings and contents was compiled into four areas of functions. These functional divisions are: (1) Evaporation, (2) Separating-Churning, (3) Administration, and (4) Boiler room. This break-down in operational activity was selected in order to facilitate the apportioning of all charges to the two chief products involved in the plant models.

The applicable and prevailing insurance rates for this area (as noted by the local insurance agencies) were applied to the total functional area costs. The fire insurance rates follow:

A. The rate for a masonry type of structure, as used for the model plants, is sixty-five cents for each one hundred dollars of valuation that is covered.

B. On the contents, the commercial rate is fifteen cents for each hundred valuation of property insured.

The over all coverage, for both buildings and contents, was calculated on eighty per cent of total cost, due to the cheaper co-insurance rates. Then, costs were determined on daily, monthly and yearly time periods, for the four functional divisions. Details of the summarized findings are given for plants A and B in Tables X and XI.

Liability and Compensation Insurance

The wages and salaries costs were grouped into three functional areas. The areas are: (1) Evaporation, (2) Processing, and (3) Administration.

The two applicable rates are:

A. A charge of 14 cents for each one hundred dollars in wages for the liability insurance.

B. Compensation insurance cost that was used is ninety cents for each one hundred dollars in wages.

C. The 1960 social security rate is three per cent of the total wage cost.

All three of the charges were figured and compiled, for both plant models, as shown in Table XII.

Interest Cost

The determination of this daily input charge was founded on several vital assumptions, which are as follows:

(1) The total amount of the investment had to be borrowed.

(2) It was not practical to average the daily cost over the period of years during which the funds are to be repaid.

(3) It is economically wise to charge interest on all invested capital in order to equate the efficiency of operation between going entities.

(4)Interest cost should be figured on the basis of one year and then broken into monthly and daily costs.

(5) The annual rate-of-interest was five and one-half per cent, since this is an actual rate, for recently borrowed funds. However, the Bank for Cooperatives is charging higher rates.

Calculation of the total interest cost was based on the areas of functions, the above six assumptions, and is recorded in Table XIX for plants A and B.

Property Taxes

Research studies made in South Dakota have shown that assets of the type used in the model plants are assessed, for tax purposes, at a state average of 57.7 per cent of its market value. There is an assumed average general tax levy of 30 mills for the state. When these rates were applied, the resulting tax,on a daily, monthly, and yearly basis —

TABLE X. COST OF FIRE AND EXTENDED COVERAGE INSURANCE
(PLANT A)

Areas	Insurance Cost Total cost	80 per cent coverage	Yearly* cost	Monthly cost	Daily cost
Evaporating					
Building	$88,524.40	$ 70,819.52	$ 460.32	$ 38.36	$ 1.28
Contents	143,434.00	114,747.20	172.12	14.34	.48
Sub-totals	(231,958.40)		(632.44)	(52.70)	(1.76)
Separating and Churning					
Building	$ 76,183.78	60,948.62	$396.16	$33.01	$1.10
Contents	100,328.00	80,262.40	120.39	10.03	.34
Sub-totals	(176,513.78)		(516.55)	(43.04)	(1.44)
Administrative					
Building	$36,659.88	29,327.90	$19,063.00	$15.89	$ .53
Contents	6,055.00	4,844.00	727.00	.61	.02
Sub-totals	(42,714.88)		(19,790.00)	(16.50)	(.55)
Boiler room					
Building	$17,482.42	13,985.94	$ 90.91	$ 7.58	$ .25
Contents	48,116.00	38,492.80	57.74	4.81	.16
Sub-totals	(65,598.42)		(148.65)	(12.39)	(.41)
Totals			$ 1,495.54	$ 124.63	$ 4.16

*Masonry type building insurance is sixty-five cent per hundred dollar value, and contents rate is fifteen cents per hundred value.

TABLE XI. COST OF FIRE AND EXTENDED COVERAGE INSURANCE
(PLANT B)

	Insurance Cost				
Areas	Total cost	80 per cent coverage	Yearly* cost	Monthly cost	Daily cost
Evaporating					
Building	$ 88,681.48	$ 70,945.18	$461.14	$38.43	$1.28
Contents	180,186.00	144,148.80	216.22	18.02	.60
Sub-totals	(268,867.48)		(677.36)	(56.45)	(1.88)
Separating-Churning					
Building	$ 76,139.16	60,911.33	$395.92	$32.99	$1.10
Contents	112,939.00	90,351.20	135.53	11.29	.38
Sub-totals	(189,078.16)		(531.45)	(44.28)	(1.48)
Administrative					
Building	$36,646.02	29,316.82	$190.56	$15.88	$ .53
Contents	6,055.00	4,844.00	7.27	.61	.02
Sub-totals	(42,701.02)		(197.83)	(16.49)	(.55)
Boiler room					
Building	$17,385.82	13,908.66	$90.41	$7.53	$ .25
Contents	48,116.00	38,492.80	57.74	4.81	.16
Sub-totals	(65,501.82)		(148.15)	(12.34)	(.41)
Totals			$1,554.79	$129.56	$4.32

*Masonry type building insurance is sixty-five cents per hundred value and contents rate is fifteen cents per hundred.

TABLE XII. DAILY COST OF WORKERS LIABILITY AND COMPENSATION INSURANCE
(BY PLANTS AND AREAS)

Plants - Areas	Wages	Liability Insurance* rate	Liability Insurance* amount	Workers' Compensation** rate	Workers' Compensation** amount	Social*** Security
Plant A						
Evaporation	$54.96	$ 0.14 per hundred	$ .0769	$ 0.90 per hundred	$ .4946	$1.65
Processing	40.50		.0567		.3645	1.22
Administrative	50.05		.0701		.4505	1.50
Daily cost	$145.51		$ .2037		$ 1.31	$4.37
Plant B						
Evaporation	$ 54.96		$ .0769		$ .4946	$1.65
Processing	44.26		.0619		.3983	1.33
Administrative	50.05		.0701		.4505	1.50
Daily cost	$149.27		$ .209		$ 1.35	$4.48

*Rate is .14 per hundred wages.

**Rate is .90 per hundred wages.

***Rate is 3 per cent of the total wage.

is given by areas and totals for the models, in Tables XIII and XIV. Since this study is concerned with only the costs of manufacturing, there was no consideration given to profit taxes.

The assumed average tax is used because a true tax average for all counties is not known. According to Professor John Thompson of the Economics department at South Dakota State College, the mill levy on "non-agriculture" property ranged from 19 to 58. He further stated that the majority of the counties have a mill levy ranging from 25 to 35. For this reason, the 30 mills average was selected. Also, it should be noted that the yearly tax is based on the first year of operation. The amount of taxes that must be paid during the following years is not expected to decrease, in spite of the fact that those fixed inputs are decreasing in book value. There are several reasons for this state-of-affairs. They are as follows: (1) Inflation is expected to result in an increase in the market value of property. (2) The local tax assessor emphasized that once a tax is established for a piece of property, usually, the amount is not reduced -- there is no consideration given for depreciation. Also, (3) should an industry come into the area, any special consideration is given in the form of lower assessments. Tax manipulations that may take place during a deflationary period could not be learned.

Maintenance Cost

There is no generally accepted method by which maintenance costs

TABLE XIII. PROPERTY TAXES BY AREAS AND PERIODS FOR PLANT A

Areas	Cost or value	Assessed* value 57.7 per cent	Mills** levy 3 per cent	Yearly tax	Monthly tax	Daily tax
Evaporation	$231,958.40	$133,840.00	.03	$4,015.20	$334.60	$11.15
Separating-Churning	176,519.78	101,848.45	.03	3,055.45	254.61	8.49
Boiler room	65,598.42	37,850.29	.03	1,135.51	94.63	3.15
Administrative	42,712.88	24,646.49	.03	739.39	61.62	2.05
Totals				$8,945.55	$745.46	$24.84

* Second report real estate assessment ratio study, 1959, South Dakota Department of Revenue, p.14.

** Third annual report to the Governor, 1958, South Dakota Commissioner of Revenue.

TABLE XIV. PROPERTY TAX BY AREAS AND PERIODS FOR PLANT B

Areas	Cost or value	Assessed* value 57.7 per cent	Mills** levy 3 per cent	Yearly tax	Monthly tax	Daily tax
Evaporation	$268,867.47	$155,136.53	.03	$4,654.10	$387.84	$12.93
Separating-Churning	189,078.16	108,098.10	.03	3,242.94	270.25	9.01
Boiler room	65,501.82	37,794.55	.03	1,133.84	94.49	3.15
Administrative	42,701.02	24,638.49	.03	739.15	61.60	2.05
Totals				$9,770.03	$814.19	$27.14

*Second report real estate assessment ratio study, 1959, South Dakota Department of Revenue, p.14.

**Third annual report to the Governor, 1958, South Dakota Commissioner of Revenue.

may be predicted. Any conclusion must be subjectively reached.

Generally, in this area, the maintenance of equipment in the separation-churning section B, is a part of the duties of the chief butter maker. The person who is in charge of section A, evaporation and drying area, makes all repairs in that area. There are added expenses for labor only when these persons are required to work overtime. The cost of such labor cannot be ascertained in advance — this expense, and repair parts are not considered.

Supplies

Table XV shows specific supplies that are required by sections A and B. The cost of these inputs is based on the prices currently being paid by regional creameries. Miscellaneous supplies, for two functional areas, are listed in Table XVI. The cost shown is based on an anticipated need equal to five per cent of variable daily inputs—exclusive of labor. Also, there is a uniform daily allocation to cover such expenses as long distance calls, an occasional board of trustees meeting, and other miscellaneous expenses. For these, the sum of two-hundred and ten dollars monthly have been projected, as a requirement.

Depreciation Costs

The Internal Revenue Service Bulletin F lists suggested years over which fixed inputs should be depreciated. The period of time advocated for the type of equipment used in the models, ranged from

TABLE XV. SPECIFIC SUPPLIES COST BY PLANTS AND AREAS

Plants	Daily quantity	Monthly quantity	Cost each	Daily cost
			(cents)	(dollars)
Plant A				
Butter cartons	169.8	5,094	23	39.05
Dry-milk sacks	83.5	2,505	37	30.90
Total				69.95
Plant B				
Butter cartons	271.73	8,152	23	62.50
Dry-milk sacks	133.50	4,005	37	49.40
Total				111.90

TABLE XVI. COST OF MISCELLANEOUS SUPPLIES BY AREAS AND PLANTS (IN DOLLARS)

Plants	Separating churning*	Administration**	Daily total
Plant A	1.26	7.00	8.26
Plant B	1.74	7.00	8.74

*Based on 5 per cent of daily variable inputs (labor excluded).
**Minimum cost of $7.00 daily.

fourteen to twenty-five years. Under historical economic conditions, such a long period of time would be considered feasible. However, the life of such property may be even longer than that which is suggested, in spite of the sixteen to twenty-four hours of daily use. The great technological progress made during the past decade, as it pertains to the fixed inputs under study, indicates that the suggested number of years does not conform to reality in most instances. It is for this reason that the low figure of fifteen years has been used. It appears to be quite liberal, since many creameries use ten to twelve years as the period over which such facilities are depreciated. The calculated figures, for plants A and B, on the equipment are given by functional areas and totals in Tables XVII and XVIII.

The total cost of the plant buildings was depreciated over a period of forty years. This charge is shown as one of the inputs in Tables XXXIV and XXXV in a later chapter.

TABLE XVII. YEARLY DEPRECIATION OF EQUIPMENT BY AREAS FOR
(PLANT A)

Areas	Estimated years	Total Equipment Cost	Yearly depreciation	Daily Cost Per 100,000 Pounds
Dry-milk production	15	$143,434.00	$9,562.27	$26.21
Butter production	15	100,328.00	6,688.53	18.32
Tool room	15	1,000.00	66.67	0.18
Boiler room	15	48,116.00	3,207.73	8.79
Administrative	15	5,055.00	337.00	.92
Totals	15	$297,933.00	$19,862.20	$54.42*

*Note: The cost per pound of raw milk input is .0005442 cents.

TABLE XVIII. YEARLY DEPRECIATION OF EQUIPMENT BY AREAS FOR
(PLANT B)

Areas	Estimated years	Total Equipment Cost	Yearly depreciation	Daily Cost Per 160,000 Pounds
Dry-milk production	15	$180,186.00	$12,012.40	$32.91
Butter production	15	112,939.00	7,529.27	20.63
Tool room	15	1,000.00	66.67	0.18
Boiler room	15	48,116.00	3,207.73	8.79
Administrative	15	5,055.00	337.00	.92
Totals	15	$347,296.00	$23,153.07	$63.43*

*Note: The cost per pound of raw milk input is.000394 cents.

TABLE XIX. INTEREST COST OF INVESTMENT BY PLANTS AND AREAS

PLANT A

Areas	Total Investment	Yearly Cost*	Monthly Cost	Daily Cost
Evaporating	$231,958.40	$12,757.71	$1,063.14	$35.44
Separating-Churning	176,513.78	9,708.26	809.02	26.98
Administrative	42,714.88	2,349.32	195.78	6.54
Boiler room	65,598.42	3,607.91	300.66	10.02
Totals		$28,432.20	$2,368.60	$78.98

PLANT B

Areas	Total Investment	Yearly Cost*	Monthly Cost	Daily Cost
Evaporating	$268,867.48	$14,787.71	$1,232.31	$42.08
Separating-Churning	189,078.16	10,399.30	866.61	28.89
Administrative	42,701.02	2,348.56	195.71	6.52
Boiler room	65,501.82	3,602.60	300.22	10.01
Totals		$31,138.17	$2,594.85	$86.50

*Interest rate is 5 1/2 per cent annually.

CHAPTER IV

ANALYSIS OF LABOR COST

General

The functions of each of the two model plants were combined into three categories in order to (1) analyze labor cost and (2) ascertain the number of required workers for each phase of general operation. Then, complete work schedules were prepared for the plants. Also developed were work outlines which showed the total number of hours that a plant would operate by functions and departments; the number of workers required and their duties; and a plan for the rotation of workers on a seven day work week basis.

The conditions of employment in South Dakota creameries differ greatly from those found in many of the other Northwestern dairying states. Some of the differences are summarized below: (1) In most of the other states of the mid-west, the volume of whole milk production is so large that many plants can operate on a twenty-four hour schedule for seven days per week. South Dakota is moving in that direction. (2) Larger mid-western plants have full-time maintenance crews of two or more persons. Typical South Dakota plants have no special maintenance personnel. (3) In South Dakota the hourly rate of pay for the workers in creameries ranged from one dollar to one dollar and fifty cents. The pay scale for similar work duties in other states is considerably higher for all categories from $1.35 to $1.95 per hour worked. However, the total wage bill may be the same. The hourly wage rate is lower in South Dakota, but the overtime pay tends to equalize the net take-home pay. Generally, the hours worked per week exceed the forty-hour limit set by statute. In one plant studied, the chief foreman, who was also the maintenance person, worked, at times, seventy or more hours per week. The normal work week was eight hours daily, and seven days per week. The extra hours, however, cost time-and-a-half rate. The extra cost would have more than paid for an extra person on a forty-hour week basis. (4) In some area plants, the employees work straight through—there is not a break for eating. They eat whenever the opportunity presents itself. This is possible in non-administrative sections of the plants, since one may eat between checking on gauges and other equipment. Also, it requires about eight minutes for a sack to fill with dry milk (in one plant). It is during such periods of time that the sacker may eat, if there is no loading out of trucks, sacks to get ready, or pallets to move.

The next step was to outline a complete work program for each production worker which would cover an eight-hour day and a five-day week. The South Dakota pay scale, working conditions and customs were used as the basis on which to develop the work programs.

The work schedule was developed for a forty-hour work week in the manufacturing areas. The reason was, in the long run, moral would be higher and efficiency promoted if the workers have at least two days off each week. This conclusion was reached after observation in several plants, and talks with production workers and office staff. There was evidence of dissatisfaction, not only with the hours of work, but also, the pay scales.

Determination of Operating Hours

The number of hours that either plant had to operate, depended, basically, on the performance of the separators. Also of vital importance was the accuracy with which the machinery had been synchronized to the evaporators and the driers.

The separator anticipated for Plant A could handle whole milk at a rate of 18,000 pounds per hour, while the larger separator selected for Plant B would separate cream from the raw resource input at a rate of 25,000 pounds during the same period of time. Thus, this performance meant a basic time period for the operation of the fixed inputs, in the processing area, of six and seven hours respectively in the two plants.

The APV evaporators are of different sizes in the models. They can reduce the skim milk to forty-six per cent solids as rapidly as the variable input is received from the separators. Cooling for storage and then reheating to 190 degrees for evaporation is in this way eliminated. The overall result is a reduction in variable operating cost.

However, the evaporators and driers could not be exactly synchronized in their relative productive activities. This meant a slight storage problem unless a dryer with more than two heads was considered. A two headed dryer was believed to be the better for the smaller size plant, and even for one that would operate on a three-shift daily basis--with little excess capacity. Plant B operates ten and one-half hours per day and Plant A operates twelve hours per day. Any apparent discrepancy is due to the different sizes of the fixed inputs.

With the basic operating time known, the next task was to determine the number of workers needed in each functional area. Also, an outline of duties had to be made.

Duties of Employees by Functional Areas

Receiving

There is no labor contemplated for the receiving area of either size plant. The reason is that all whole milk will be received by bulk tank trucks. The drivers' cost of labor input, is not considered. It is assumed that they will clean and otherwise care for their trucks. However, cleaning facilities are provided by the separating-churning sections. This is the customary procedure that was found to exist. There is a hauling charge of twenty-five cents per hundred pounds of whole milk. This amount is paid by the producers. For that reason, it was assumed that all receiving costs, except the depreciation of the building receiving space, and the truck cleaning equipment, would be covered by such a charge. Some plant managers have contended that the assembly charges do not cover all procurement costs that are involved. They have stated that a part of the pick up cost is paid from what otherwise would be profit.

Separating-Churning

The processing area required a chief butter maker, who, in addition, handles the maintenance of equipment in this section. According to the work schedule prepared, he would begin his day at 7:00 a.m. by readying all facilities for receiving—this includes the operation of boilers. Presumably, the first bulk tank truck would arrive at 7:30 a.m. From this time until his day ends at 4:30 p.m., he would be separating, churning, repairing and cleaning, with thirty minutes allowed for lunch. Meanwhile, he has two helpers. The first assistant prepares boxes for the butter, readies the churn, tends the separator during the butter maker's lunch-time, boxes and stores the butter in the cooler, replaces the chief butter maker when his work day ends, and, finally, cleans this work area. His day ends at 6:30 p.m. Since the plants operate seven days a week, a relief person is necessary. This is the primary duty of the second helper for four days each week--on his fifth work day, he may print butter or catch up on the other jobs that need attention.

The only difference that exists in this functional area, between the two plants, is that in Plant B the work day ended one hour later in order that all duties could be carried out as provided in the schedule of work.

Evaporating-Drying

In the evaporating-drying section, there were more workers needed in each plant, than in the processing areas. The decision was to contemplate a requirement of six persons. Going entities in South Dakota operate drying departments with only two on duty at one time. This means that with a sufficient volume, three full-time shifts, of eight hours each, could be operated with the six workers. In this study, the work schedule of the six employees was arranged so that two or more were on duty at all times during the work day, which began at 7:30 a.m. and ended at 10:30 p.m. This activity period included two and a half hours for cleaning. The work week was seven days. In this way, security would be increased. There would be two persons on duty at all times. One could come to the assistance of the other in case of an emergency. In addition, one of the team would replace a worker two days per week—the other three days he would devote to laboratory testing and production control. If needed, he could spend a part of his time checking complaints of patrons on the different routes. The reasons for this arrangement are categorised below: (1) Workers' morale would be better if they were given two days a week for their own personal use. (2) Employers could expect greater efficiency if the personnel worked a minimum of forty hours each, a week. (3) Normally, three full-time persons and two half-time workers would have been sufficient. The part-time employees would have had to work four hours in the late afternoon and early part of the night. Also, their schedule would cover a seven-day work wee, and still, the total work week could be only twenty-eight hours. The third full-time worker's period of employment would have been four days or thirty-two hours. Such an irregular work schedule or over-time pay (if the number of workers was reduced) would not be as efficient, and the total wage bill would have been approximately the same.

<u>Administrative</u>

The administrative personnel includes a manager and two office clerks. The managerial function is considered supervisory only. In some plants the manager replaces other workers one or two days out of each work week. The models provide that the manager should think, plan, and promote efficiency of operation. At times he may visit patrons and check on complaints.

The office clerks would keep records, receive patrons, and handle resale items--should they be carried. One clerk would work a half-day on Saturday and a half-day on Sunday--they may alternate their weekends off.

Chart I shows the details of the work hours, duties, and the number of workers for both model plants. A suggested system for the rotation of workers is given in Chart II. Also, there is a tabulation which shows the number of hours that each employee should work.

In both plants the processing sections operate on a forty-hour week and an eight-hour day. Also, the office clerks work forty-four hours per week. However, the <u>evaporating-drying</u> functions call for a forty-hour week in Plant A and forty-five hours of production in Plant B.

The daily cost of labor for each of the three functional departments is given in Table XX, for both of the model plants. Hourly rates of pay and the salaries for the managers are those that are in force, at this time, in the South Dakota plants. A salary of three hundred and fifty dollars per month is higher for butter makers than in the cases of hourly pay scales. The highest rate found for any worker employed by the hour was one dollar and fifty cents. A butter maker received this amount. However, when he worked overtime on repairs, the hourly rate was two dollars and twenty-five cents. In one plant the starting hour rate is one dollar and ten cents with one dollar and twenty cents per hour as a maximum.

CHART I. WORK PLAN FOR PLANTS' A AND B EMPLOYEES
BY AREAS AND FUNCTIONS

Time	Administrative Area	
	Manager Worker Number 12	Clerks Workers Numbers 10 and 11
A. M.		
7:00		
8:00	Office—	Office—
9:00	checks and	
10:00	supervises	keep records
11:00	operations.	and wait on
12:00	Visits patrons.	the patrons.
		Lunch break.
P. M.		
1:00		Continue
2:00		clerical
3:00		duties
4:00		until
5:00		work day's
5:30		end.
10:30	All plant operations conclude.	

A continuation of Chart I.

Time	Separating-Churning Area: Butter maker Number 7	Butter maker Helper Number 6	Butter Maker Helper Number 8
A. M.			
7:00	Set up.		
7:30	Receives.		
8:00	Separates		Replaces the
8:30	and checks		Butter maker
9:00	machinery.	Starts work	and helper
9:30	Churn.	by preparing	two days
10:00		butter boxes.	each
10:30		Fills and stores	per week.
11:00	Checks.		
11:30		and places	Fifth day—
12:00		them in the	cleaning,
P. M.		cooler—	printing.
			Prepares
12:30			boxes and
1:00	Churn.		does
1:30			general
2:00	Checks.		catch-up
2:30			work.
3:00	Churn.		
3:30	Checks.		
4:00			Works 8
4:30	Day ends.	Cleans.	hours one
5:00			day per
5:30			week.
6:00			
6:30		Day ends.	
7:00			
7:30			
8:00			
8:30			
9:00			
9:30			
10:00			
10:30			

A contimation of Chart I.

Evaporating-Drying Area

Time	Number 1 Evaporator	Number 2 Sacker	Number 3 Helper	Number 5 Helper	Number 4 Helper	Number 9 Helper
A. M.						
7:00						
7:30	Set up.					
8:00	Evaporates				Takes	Lab.
8:30	and dries.	Prepares			place	control
9:00		and			of	testing
9:30		fills			workers	and
10:00	Checks.	sacks			numbers	takes
10:30		and			1 and 3	place
11:00	Repairs.	orders.			two	of
11:30					days	number
12:00	Fills				per	2
	orders				week,	worker
P. M.	and does				and	one day
					number	per
12:30	other				2 on	week.
1:00	jobs				one	
1:30					day	Takes
2:00	that				per	place
2:30	are		Starts.	Starts.	week.	of
3:00	necessary.		Does	Does		
3:30	Day ends.					number
4:00			general	general		5 on
4:30		Day ends.	work.	repairs.		two
5:00			Replaces	Replaces		days
5:30			evaporator	sacker		per
6:00				five		week.
6:30				days per		
7:00			and	week.		
7:30						
8:00			cleans.			
8:30						
9:00						
9:30				Cleans.		
10:00						
10:30			Day ends.	Day ends.		

Conclusion of Chart I.

Administrative Area	Manager Worker 12	Clerks Workers 10 & 11
PLANT B		
Daily hours	Unlimited hours	8
Weekly hours		44
PLANT A		
Daily hours		8
Weekly hours	Unlimited hours	40

Separating-Churning Area	Butter maker Number 7	Butter maker Helper Number 6	Butter maker Helper Number 8
PLANT B			
Daily hours	8	8	8
Weekly hours	40	40	40
PLANT A			
Daily hours	8	8	8
Weekly hours	40	40	40

Evaporating-Drying Area	Number 1 Evaporator	Number 2 Sacker	Number 3 Helper	Number 5 Helper	Number 4 Helper	Number 9 Helper
PLANT B						
Daily hours	9	9	9	8	8	8
Weekly hours	45	45	44	40	40	40
PLANT A						
Daily hours	8	8	8	8	8	8
Weekly hours	40	40	40	40	40	40

CHART II. ROTATION OF EMPLOYEES BY AREAS AND DAYS OF WEEK FOR PLANTS A AND B

Areas	Separating - Churning			Evaporation		Sacking	
Work hours	8:00-4:30	7:00-4:30	10:00-6:30	7:30-3:30	2:30-10:30	8:30-4:30	4:30-7:30
Days	Workers by Numbers			Workers by Numbers			
Monday		8	6	1	4	2	5
Tuesday		8	6	1	4	2	5
Wednesday	8	7	6	1	3	4	5
Thursday		7	6	1	3	2	5
Friday		7	6	1	3	2	5
Saturday		7	8	4	3	9	9
Sunday		7	8	4	3	2	9

Areas	Administrative	
Work hours	8 to 12	and 1 to 5
Days		
Monday	12	10 and 11
Tuesday	12	10 and 11
Wednesday	12	10 and 11
Thursday	12	10 and 11
Friday	12	10 and 11
Saturday	12	10
Sunday	12	11

Workers Numbers	Hours Worked
1	40
2	40
3	40
4	40
5	40
6	45
7	45
8	44
9	40
10	44
11	44
12	Unlimited (Manager)

TABLE XX. WAGES COST DAILY BY AREAS FOR PLANTS A AND B

Workers Numbers	Weekly Hours worked	Hours Adjusted for Overtime	Pay rates	Monthly Weekly	Daily Cost	Cost by Areas Evaporation	Processing	Administrative
1	40	40	$1.35	$54.00	$10.80	$10.80		
2	40	40	1.20	48.00	9.60	9.60		
3	40	40	1.20	48.00	9.60	9.60		
4	40	40	1.20	48.00	9.60	9.60		
5	40	40	1.20	48.00	9.60	9.60		
6	45	47 1/2	1.25	59.38	11.88		$11.88	
7	45	47 1/2		350.00	17.50		17.50	
8	44	46	1.20	55.20	11.04		11.04	
9	40	40	1.20	48.00	9.60	5.76	3.84	
10	44	46	1.00	46.00	8.36			$8.36
11	44	46	1.00	46.00	8.36			8.36
12	unlimited hours			1000.00	33.33			33.33
Totals Plant B					$149.27	$54.96	$44.26	$50.05
Totals Plant A*					$145.51	$54.96	$40.50	$50.05

*Plant A differs from Plant B due to the eight-hour day instead of the nine-hour day needed for processing in Plant B.

CHAPTER V

COSTS OF OTHER VARIABLE INPUTS

General

The variable inputs to be considered in this chapter are the daily KWH consumption of electricity in both Plants A and B; the oil requirement to meet the need of each functional area, and facets thereof; the water consumption for each section of the prodnction unit; and the amount of natural gas needed for the total operation.

The method of calculation for each input will be given in some detail. The unit cost employed is that going charge indicated by the concerned private utilities corporations of this area, or that which has been set by a municipality that operates such an enterprise.

Procedures for all calculations are those recommended by specialists, either in dairying or dairying-engineering operations. The final results, as approved by such persons, are given in tables on the analysis of inputs costs, which are found in this chapter.

Consumption of Electricity

In order to compute the electric power requirement, it was first necessary to determine the horse-power of each motor, in all functional sectors. However, the requirement for lighting was based on the square feet in each area. Also, the number of hours that each motor would be required to operate, in order to handle the assumed volumes, had to be determined. To do this, the equipment, with motors, was grouped into four operative areas. They are evaporation, separating-churning, receiving and administration. There were two primary engineering suggestions. They follow: (1) It is customary to assume that, for operations of this nature, any motor will use one KWH per hour per horse-power during its performances. (2) Lighting requirement is 30 KWH per day for each thousand square feet of floor space.

The results obtained were 771 KWH needed daily by Plant A, and a daily requirement of 1092.5 KWH by Plant B. Local power rates that are currently in force were used. The first 500 KWH cost 4.5 cents; the next 1500 KWH cost 3 cents; and any amount over 2000 KWH cost 2.5 cents each. Daily and monthly costs, by departments, for the model plants, are recorded in Tables XXI and XXII.

Oil Requirement

The fuel oil requirement was determined with the aid of a production specialist as consultant. The distributor for an oil firm stated that fuel used in this area and handled by him has a BTU rating of 154,000 per gallon for number five oil. This oil can be "cut"* if needed. The prices of oil, however, depend on numerous factors. Some of them are: (1) The season of the year. (2) Degree of existing competition. (3) How badly the distributor wants the business. (4) The amount of the remuneration that a distributor expects in return for his labor or service.

*"Cut" is a term used by a local distributor to indicate that the weight or viscosity of oil can be changed to meet the need or particular requirement.

TABLE XXI. ELECTRICITY CONSUMPTION PER 100,000 POUNDS OF WHOLE MILK BY AREAS, AND COST FOR PLANT A

Areas	Daily KWH	The Per cent of Total	Monthly cost	Daily cost
Evaporation	410	53.18	$316.82	$10.56
Separating-churning	294	38.13	227.16	7.57
Receiving	7	.91	5.42	0.18
Administrative	60	7.78	46.35	1.55
Totals	771	100.	$595.75	$19.86

TABLE XXII. ELECTRICITY CONSUMPTION PER 160,000 POUNDS OF WHOLE MILK BY AREAS, AND COST FOR PLANT B

Areas	Daily KWH	The Per cent of Total	Monthly cost	Daily cost
Evaporation	688.30	62.99	$527.38	$17.58
Separating-churning	333.50	30.52	255.53	8.52
Receiving	11.00	1.00	8.37	.28
Administrative	60.00	5.49	45.97	1.53
Totals	1,092.50	100.	$837.25	$27.91

(5) Size of the volume purchased. Finally, (6) How busy the refineries are at the time of purchase.

Quoted price, at the time, for number five oil per gallon was .1405--tax included. However, there appeared to be a slight disagreement between the manager and a chief salesman on the price that should be quoted, for fear of competitors, and the BTU content per gallon, since the oil could be "cut".

The calculation results are recorded in Table XXIII for Plant A and Table XXIV for Plant B.

TABLE XXIII. OIL CONSUMPTION BY AREAS IN GALLONS, AND COST (PLANT A)

Areas	Gallons	The Cost Per Gallon	Daily total cost
Churning-Pasteurizing	(95)	.1405	$13.35
Separating	47.25		
Pasteurizing	32.17		
Cleaning floors	6.11		
Truck receiving	9.50		
Evaporating	(44.30)	.1405	6.22
Cleaning	6.12		
Evaporation	38.24		
			$19.57

Note: Cost per 1000 pounds whole milk (.1957)

TABLE XXIV. OIL CONSUMPTION BY AREAS IN GALLONS, AND COST
(PLANT B)

Areas	Gallons	Cost Per Gallon	Daily total cost
Churning-Pasteurizing	(153)	.1405	$21.50
Separating	79.59		
Pasteurizing	51.48		
Cleaning floors	6.11		
Truck receiving (cleaning)	15.90		
Evaporating	(67.37)	.1405	9.47
Cleaning	6.12		
Evaporation	61.25		
			$30.97

Note: Cost per 1000 pounds whole milk (.1936)

A quantity of the fuel required to raise the temperature, from the level at which the raw resource input was received, to the level needed for separation, was computed as follows:

$$\frac{\text{Pounds of Milk X } (90^{\circ} - 40^{\circ}) \text{ X } .93 \text{ X } 1.33}{.85} = \frac{\text{Total BTU's}}{154{,}000} = \text{the}$$

gallons of number five fuel oil needed. The $90^{\circ} - 40^{\circ}$ represents the temperature change from receiving to separating that is necessary; the specific heat of whole milk is .93; .85 is a heat loss factor; and 1.33

is the boiler efficiency element. At this stage there was no advantage taken of the regenerative heat possibility——this was not needed. The BTU's, so determined, were divided by 154,000 BTU—(the amount in one gallon of fuel oil)—to give the oil requirement for this operation.

A similar calculation was made for cream pasteurizing. The formula that was used is:

$$\left(\frac{\text{Pounds of cream} \times (190^\circ - 90^\circ) \times .77}{.85}\right) \times .47 \times 1.33 \div 154{,}000 \text{ BTU's.}$$

This gave the amount of oil needed to pasteurize the cream. The factor of .77 is the specific heat of cream; 1.33 the efficiency of the boilers; the regenerative possibility of using the cream that has been pasteurised to raise the temperature of the incoming resource is forty-seven per cent efficient; and the .85 accounts for loss of heat in pipes.

A conservative engineering estimate of the amount of fuel needed to heat water for the cleaning areas is based on a pound of steam for each four or five square feet of space to be cleaned. Four square feet was used in this problem. A pound of steam has 1181 BTU's. Also used was the 1.33 efficiency factor of boiler function, and 154,000 BTU's per gallon of oil. This gave the amount of oil needed in cleaning. The formula used to get the oil requirement for cleaning the floor area was:

$$\frac{\text{Square Feet Area}}{4} \times \text{BTU's in Steam} \times \text{Boiler Efficiency} \div \text{BTU's in oil.}$$

This gave $\left(\frac{2400}{4} \times 1181 \times 1.33 \right) \div 154{,}000$ for the evaporation area and $(\frac{2398}{4} \times 1181 \times 1.33) \div 154,000$ for the separating-churning area or 6.11 gallons of oil, as shown in Tables XXIII and XXIV.

Cleaning in the bulk truck receiving area was calculated. It was assumed that there would be six truck loads of whole milk received daily by Plant A and 10 truck loads by Plant B; that 150 gallons of water, which has a weight per gallon of 8.35 pounds, would be required for cleaning each truck; the temperature change of the water would be $175^\circ - 50^\circ$; a heat factor of 1.176; and 1.33 for boiler efficiency. Thus (6 trucks or 10 trucks X 150 gallons X 8.35) X (125° X 1.176 X 1.33) $\div$ 154,000 gave fuel requirements for truck cleaning.

In order to evaporate, the skim milk has to be raised from a 90° temperature to 170 degrees. The specific heat factor is .95, and an efficiency factor of .85 is assumed. A skim milk factor had to be added since the solid contents are to be reduced to forty-six per cent. The formulas turn out to be: For Plant A —

$$(\text{Skim milk } (91,250) \times (170^\circ - 90^\circ) \times \text{Specific heat } (.95) \times .85 \text{ efficiency factor}) + (\text{Pounds of skim milk } \frac{(2500)}{7300} \times 1176 \text{ BTU} \times 1.33)$$

$\div$ 154,000 BTU's gave the fuel requirement.

For Plant B —

$$(\text{Skim milk } (146,000) \times 80^\circ \times .95 \times .85) + \frac{3300}{1100} \times 1176 \times 1.33) \div 154,000$$

was the amount of oil needed.

Water Requirement

The total water need for the two plants, after calculation, was summed by functional areas, and recorded in Tables XXV and XXVI. Since the cost of this variable input is stated in price per cubic foot, all the sectional usages had to be so reduced. The unit used was 1 cubic foot of water = 7.5 gallons.

The amount of water consumed depended on the amount of cream to be cooled; the frequency, usually daily, with which the equipment is cleaned; the amount of input of the variable resource involved; and the requirements for floor, truck and machinery cleaning. These amounts were estimated from the published information on the equipment by manufacturers, and the help of a production consultant.

To the amounts, so determined, was applied the local rate for the water and use of the sewer system. The applicable commercial rates are one dollar and twenty-five cents for the first 300 gallons, 25 cents per hundred for the next 3000 gallons, twenty cents per hundred for the next 3500 gallons, the next 60,000 gallons cost 16 cents per hundred, and any amount above this cost 12 cents per hundred gallons. The total monthly cost was determined, then prorated on a daily cost by functions — this was based on the percentage relationship of departmental use of water. Finally, the cost of using the municipal sewer system was calculated. This cost is seventy-five per cent of the total water bill.

Gas Consumption

Evaporation of the forty-six per cent solid input to a consistency with only 3.5 moisture content is done with gas. The quantity of gas

TABLE XXV. WATER CONSUMPTION AND COST BY AREAS
(PLANT A)

Areas	Gallons	Cubic feet	Per Cent of Total	Monthly** cost	Daily cost	Sewer* Rent
Evaporation	(50600)	6747	91.67	$271.62	$9.06	$6.79
Evaporating	49700.					
Cleaning	900.					
Separating-Churning	(2100)	280	3.80	11.26	0.37	.28
Cleaning	1200.					
Truck cleaning	900.					
Administrative	(2500)	333	4.53	13.42	0.45	.34
Total		7360	100.00	$296.30	$9.88	$7.41

**Cubic feet rate: 300 @ $1.25; 3000 @ 25¢ hundred; 3500 @ 20¢ hundred; 60,000 @ 16¢ hundred; the rest @ 12¢ hundred.

*Rent is 75 per cent of water cost.

used depends on the amount of the semi-finished product, and the output rate of the equipment. The smaller plant's input-output rate is 600 pounds per hour. The rate is 1200 pounds per hour for the larger plant. For each two heads in the evaporator, the gas consumption is 1.8 million BTU's per hour of operating time. To determine the time requirements, for both plants, the daily output was calculated. The formula:

$$\frac{\text{Daily powder milk produced}}{\text{Output ratio per hour}}$$ gave the operating period

for the plants. Operation hours, times the hourly rate of gas consumption, and the number of days that the plant would operate resulted in

TABLE XXVI. WATER CONSUMPTION AND COST BY AREAS
(PLANT B)

Areas	Daily Gallons	Cubic Feet	Per Cent of Total	Monthly** Cost	Daily Cost	Sewer* Rent
Evaporation	(80350)	10723.	93.91	$415.08	$13.84	$10.39
Evaporating	79450					
Cleaning	900					
Separating-Churning	(2700)	360	3.16	13.97	0.47	.35
Cleaning	1200					
Truck cleaning	1500					
Administrative	(2500)	334	2.93	12.95	0.43	.32
Total		11407	100.	$442.00	$14.74	$11.06

**Cubic feet rate: 300 @ $1.25; 3000 @ 25¢ hundred; 3500 @ 20¢ hundred; 60,000 @ 16¢ hundred; the rest @ 12¢ hundred.
*Rent is 75 per cent of water cost.

the monthly BTU's needed. Since the price of gas is quoted in terms of therms, the monthly BTU's utilization had to be converted. This was figured on the basis of 1000 BTU's equal one cubic foot, and one hundred cubic feet are needed to equal a therm. The monthly therm of consumption was ascertained because of the practice of figuring monthly charges. The equation is: $\frac{\text{Pounds of daily powdered milk}}{\text{Output of equipment}}$ X 1.8 million BTU's of gas X 30 days = monthly BTU in millions. Total $\frac{\text{BTU's}}{\text{100 BTU's}}$ = Total cubic feet ÷ 100 = the therms of gas consumed monthly. Commercial rate charged for gas was procured from distributor's contracts that are currently in force. The rates are: first 250 therms cost 30 dollars or 12 cents each; second 250 therms at five cents each; the next five hundred therms cost .045 cents for each; the next 3000 therms can be procured at a cost of .04 cents each; while any amount of consumption above this cost only .035 cents for each therm. See Table XXVII for costs of gas needed by each plant—the volume of gas consumed is adjusted automatically for fluctuating pressures.

TABLE XXVII. GAS CONSUMPTION IN THERMS BY PLANTS AND MONTHLY COST

Plant	Powder milk in pounds	Operation hours	Millions BTU	Monthly BTU in millions	Cubic Feet BTU	Monthly Therms	Monthly Cost
A	8,346	9.5	17.10	513.	513,000	5,130.	$235.05
B	13,353	11.13	40.	1,200.	1,200,000	12,000.	$465.00

CHAPTER VI

COMPARATIVE UNIT COSTS OF MANUFACTURED PRODUCTS

General

The distribution of all costs to the final products had to be carried out in stages. Some of the costs were directly allocated to the products, while other costs had to be dispersed first to the functional area and then to the related subsidiary areas of activities. Finally, from the subsidiary areas the costs were distributed to the finished products. This procedure was used because it was possible to determine the exact usages by a functional area of certain inputs or their service flow. Also, aiding the procedure was the fact that particular input factors were used by one or two areas of operation. It was necessary to distribute the total of the other costs to the manufacturing and service areas. The costs of the subsidiary service areas were allocated among the varied activity areas. In order to do this, it was necessary to: (1) distribute the building costs to the four functional areas; (2) calculate the daily quantity of butter and dry-milk powder produced; (3) determine the daily comparative market value of products manufactured; and (4) consolidate all elements of cost (except whole milk) into a composite "unit cost" for each of the two commodities, by the model plants.

After the daily unit costs of the inputs-outputs had been determined the whole milk input cost was calculated by the use of two methods, and the cost per pound of each finished product was computed with both methods. The methods used follow:

A. Relative weighted market value method.

B. Departmental transfer value method.

Finally, after pointing out some of the factors that may affect costs in different plants and locations, an effort was made to ascertain which of the two "methods" would be the more appropriate.

Distribution of Service Areas Building Costs

The distribution of the cost of building construction presented several complex problems. However, the decision was reached on methods of allocating the fixed inputs that were believed to be the more equitable. There were five functional service areas of the plants involved. The areas were: 1. The space for the storage of chemicals. 2. Space used as a repair shop. 3. The boiler room. 4. All areas classed as parts of the administrative section. 5. Other dry storage space.

There was not any one basic method judged to be adequate and applicable to each area. The consequence was that different assumptions were employed for each apportionment. The functional service area building costs were distributed on the following basis:

(1) The chemical storage area was divided on the basis of the amount of square footage of occupied floor space for evaporation, processing of butter, the boiler room area, and with the balance of the floor space being lumped together as the administrative section.

(2) The repair shop area cost was allocated on the basis of the relative equipment value of each operational section. The bulk receiving

area was combined with the butter processing area.

(3) The dry or general storage space was allocated on the assumption that the more equitable basis would be the percentage of total area occupied for powder-milk and butter manufacturing, and administrative purposes. Generally, then, the above specific costs spread, along with the building costs of areas that required no dispersion, were compiled into Tables XXVIII and XXIX. Also, shown in those tables is the percentage realtionship which exists between the four functional areas and the total building cost systematized from the respective inputs of each model plant.

TABLE XXVIII. DISTRIBUTION OF BUILDING COSTS AMONG MAJOR FUNCTIONS*
(PLANT A)

Areas	Cost	Boiler room	Administration	Dry Milk	Butter
Powder milk	$78,631.00			$78,631.00	
Bulk handling	14,135.80				$14,135.80
Butter production	56,262.64				56,262.64
Administration	21,311.64		$21,311.64		
Chemical storage	5,670.00	$ 424.12	1,750.88	2,037.24	1,457.76
Dry storage	17,502.80		8,751.40	5,834.28	2,917.12
Boiler room	16,380.00	16,380.00			
Repair shop	4,200.00	678.30	87.36	2,021.88	1,412.46
Resale	4,758.60		4,758.60		
Total cost	$218,852.48	$17,482.42	$36,659.88	$88,524.40	$76,185.78
*Percentages of total------	100.	7.99	16.75	40.45	34.81

TABLE XXIX. DISTRIBUTION OF BUILDING COSTS AMONG MAJOR FUNCTIONS *
(PLANT B)

Areas	Cost	Boiler room	Administration	Dry Milk	Butter
Powder milk	$78,631.00			$78,631.00	
Bulk handling	14,135.80				$14,135.80
Butter production	56,262.64				56,262.64
Administration	21,311.64		$21,311.64		
Chemical storage	5,670.00	$424.12	1,750.88	2,037.24	1,457.76
Dry storage	17,502.80		8,751.40	5,834.28	2,917.12
Boiler storage	16,380.00	$16,380.00			
Repair shop	4,200.00	581.70	73.50	2,178.96	1,365.84
Resale	4,758.60		4,758.60		
Total cost	$218,852.48	$17,385.82	$36,646.02	$88,681.48	$76,139.16
*Percentages of total	(100.)	(7.94)	(16.75)	(40.52)	(34.79)

Daily Butter and Dry-Milk Production

Butter Production

The quantity of butter produced daily in the two plants, A and B, from the raw resource variable input was recorded as shown by Table XXX.

Both plant volumes, 100,000 pounds of whole milk for Plant A and 160,000 pounds for Plant B, were assumed to have 3.5 per cent butter-fat. The concentrate from which butter is churned has forty per cent cream, which produced 4,277.8 pounds of butter in the A plant and 6,844.5 pounds in the B model. The butterfat content per pound is 80.5 per cent--this is considered to be the U. S. standard fat content for A and AA grades of butter. However, 80 per cent fat is normally accepted as standard. The over run in the models is 22.223 per cent. Also, there was an allowance of two per cent for losses due to errors in calculation, plant or other waste, and stickage to pipes and containers.

Dry-Milk Production

Skim milk from which powder milk is produced is assumed to contain 8.88 per cent solids. When the solid content ratio was applied to the volume of skim milk, the resulting quantity of dry-milk was 8,103 pounds and 12,964 pounds respectively for the two plants.

The Commodity Credit Corporation accepts as maximum, a moisture content of 3.5 per cent. In this research project the maximum was limited to three per cent of moisture content, as a precaution. The results were an increase in the pounds of dry-milk from the 100 per cent solid as follows: from 8,103 to 8,340 pounds for Model Plant A, while the jump in Model Plant B was from 12,964 to 13,353 pounds of powdered milk. This data has been recorded in Table XXXI.

Daily Comparative Market Value of Products

The USDA report [13] showed the average prices per pound of butter and powder milk for the July-September quarter in 1959 to be 60.23 and 13.57 cents respectively. These contemporary prices had a pound for pound ratio of 81.6 per cent for butter and 18.4 for dry-milk. However, when they were weighted with the output of the commodities by the models,

[13] The Dairy Situation, November, 1959, Agricultural Market Service, United States Department of Agriculture Report, p. 2.

relative market ratios became 69.47 and 30.53 per cent. This is a reduction of twelve per cent for the relative market value of butter, while that for dry milk increased by the same percentage.

Thus, any expenses apportioned on the unweighted relative market value shift more of the burden to butter; at the same time relieving dry-milk of part of the cost.

The weighted and unweighted percentages are given in Table XXXII for Model A and Table XXXIII for Model B. Also, shown in the tables are the total market values of products produced by models.

"Unit Cost" of Finished Products

<u>General</u>

Costs, other than the raw resources input of whole milk, were determined for seventeen input factors. Three of these factors are fixed inputs, while the other fourteen are variable inputs. These inputs costs were apportioned between four functional areas; boiler room, administration, evaporation (powder-milk), and processing of butter. Then, in Table XXXIV for Model Plant A and Table XXXV for Model Plant B, the seventeen factors were combined into two components. One was the total daily cost for production of powder milk, while the other was the cost of processing the daily output of butter. However, these "total daily costs" did not include the cost of whole milk.

Two of the major cost groupings, boiler room and administration, were divided between the two commodities——butter and dry-milk——on

TABLE XXX. DAILY POUNDS OF BUTTER FROM WHOLE MILK
BY PERCENTAGES OF FAT CONTENT
(PLANTS A AND B)*

Plants	Pounds Whole Milk	Pounds 3.5 per cent fat	40 Per Cent Cream	Butter	Pounds 80.5 per cent fat**
A	100,000	3,500	8,750		4,277.81
B	160,000	5,600	14,000		6,844.49

*Over run is 22.223 per cent.

**2 per cent allowed for errors, waste and stickage.

TABLE XXXI. POUNDS OF POWDER MILK PRODUCED DAILY
BY PLANTS A AND B

Plants	Skim milk	8.88 per cent solids	3 per cent moisture
A	91,250	8,103	8,346
B	146,000	12,964	13,353

the basis of their relative market value.

The result of the synthesis was that in Plant A the daily production of 4,277.8 pounds of butter cost 232.71 dollars, and 8,346 pounds of dry-milk with three per cent moisture cost 239.13 dollars for the output. Similarily, 6,844.5 pounds of butter cost 274.62 dollars. While the expenses of 13,353 pounds of powder milk output was 298.17 dollars for Plant B.

TABLE XXXII. MARKET VALUE OF PRODUCTS, AND PERCENTAGES (PLANT A)

Products	Pounds per day	Market value* (per pound)	Per cent of value (unweighted)	Total value	Percentage of total value (weighted)
Butter	4,277.81	$60.23	81.6	$2,576.52	69.47
Powder milk	8,346.00	13.57	18.4	1,132.55	30.53
Totals			100.	$3,709.07	100.

*Average prices per pound for the period July-September 1959 - USDA report.

TABLE XXXIII. MARKET VALUE OF PRODUCTS, AND PERCENTAGES (PLANT B)

Products	Pounds per day	Market value* (per pound)	Per cent of value (unweighted)	Total Value	Percentage of total value (weighted)
Butter	6,844.49	$60.23	81.6	$4122.44	69.47
Powder milk	13,353.	13.57	18.4	1812.	30.53
Totals				$5934.44	100.

*Average prices per pound for the period July-September 1959 - USDA report.

TABLE XXXIV. COST OF INPUT RESOURCES FOR FINISHED PRODUCTS FROM 100,000 POUNDS OF WHOLE MILK BY KIND OF INPUTS (PLANT A)

Areas	Total cost	Cost, Yearly	Monthly cost	Total daily costs	Tool room	Boiler room	Administration	Powder milk	Butter
Social Security		$ 1,537.20	$131.10	$ 4.37			$1.50	$1.65	$1.22
Equipment Depreciation	$297,933.00	19,862.20	1,632.60	54.42	$ .18	$8.79	.92	26.21	18.32
Building Depreciation	218,852.48	5,471.31	449.70	14.99		1.20	2.51	6.06	5.22
Oil		7,143.05	587.10	19.57				6.22	13.35
Water		3,555.60	296.30	9.88			.45	9.06	.37
Gas		2,820.60	235.55	7.84				7.84	
Electricity		7,149.00	595.75	19.86			1.55	10.56	7.75
Labor		52,383.60	4,365.30	145.51			50.05	54.96	40.50
Sewer rent		2,667.60	222.30	7.41			.34	6.79	.28
Fire Insurance		1,495.54	124.63	4.16		.41	.55	1.76	1.44
Property taxes		8,945.55	745.46	24.84		3.15	2.05	11.15	8.49
Interest Expense		28,432.20	2,368.60	78.98		10.02	6.54	35.44	26.98
Telephone		102.00	8.30	.28			.28		
Specific Supplies		25,182.00	2,098.50	69.95				30.90	39.05
Misc.& General Supplies		2,973.60	247.80	8.26			7.00		1.26
Liability Insurance		75.60	6.30	.21			.07	.08	.06
Compensation Insurance		471.60	39.30	1.31			.45	.50	.36
				$471.84	$ .18	$23.57	$74.26	$209.18	$164.65
							$74.26*	22.66	51.60
						$23.57*		7.20	16.37
					$ .18			.09	.09
Total Daily Costs				$471.84				$239.13**	$232.71**

*Distributed on basis of relative market values of butter and dry-milk.

**The cost of whole milk is not included.

TABLE XXXV. COST OF INPUTS RESOURCES FOR FINISHED PRODUCTS
FROM 160,000 POUNDS OF WHOLE MILK BY KINDS OF INPUTS
(PLANT B)

Areas	Total cost	Yearly cost	Monthly cost	Total daily costs	Daily Costs: Tool room	Boiler room	Administration	Powder room	Butter
Social Security		$1,610.40	$ 134.20	$ 4.48			$1.50	$1.65	$ 1.33
Equip. Depreciation	$347,296.00	23,153.07	1,902.90	63.43	$ .18	$8.79	.92	32.91	20.63
Bldg. Depreciation	218,852.48	5,471.31	449.70	14.99		1.19	2.51	6.07	5.22
Oil		11,304.05	929.10	30.97				9.47	21.50
Water		5,306.40	442.20	14.74			.43	13.84	.47
Gas		5,580.00	465.00	15.50				15.50	
Electricity		10,047.00	837.25	27.91			1.53	17.58	8.80
Labor		53,737.20	4,478.10	149.27			50.05	54.96	44.26
Sewer rent		3,981.60	331.80	11.06			.32	10.39	.35
Fire Insurance		1,554.79	129.56	4.32		.41	.55	1.88	1.48
Property tax		9,770.03	814.19	27.14		3.15	2.05	12.93	9.01
Interest Expense		31,138.17	2,594.85	86.50		10.01	6.52	41.08	28.89
Telephone		102.00	8.50	.28			.28		
Specific Supplies		40,284.00	3,357.00	111.90				49.40	62.50
Misc. & General Supplies		3,146.40	262.20	8.74			7.00		1.74
Liability Insurance		75.00	6.30	.21			.07	.08	.06
Compensation Insurance		486.00	40.50	1.35			.45	.50	.40
Totals				$572.79	$ .18	$23.55	$74.18	$268.24	$206.64
							74.18*	22.65	51.53
						$23.55*		7.19	16.36
					$ .18				
				$572.79				$298.17**	
Total Daily Costs									$274.62**

*Distributed on the basis of relative market values of butter and dry-milk.
**The cost of whole milk is not included.

Cost of Output Per Pound

General

The present method of costing employed by most creameries is evidence of certain accompanying problems. They are causing much concern to dairy plant managers. This is particularly true when a plant procures skim-milk directly from producers or from other creameries which do not have drying facilities. For this reason thinking on the problem appeared to be effective when approached with more than one method. Therefore, this awareness resulted in two approaches. They are: (a) The costing of each pound of product is based on the relative market value, weighted, of the two commodities, for both plants. (b) Output costing is the result of the presently employed departmental transfer method of charging out or in of the skim-milk.

It should be remembered, at this point of unit costing, that the only input with which we are concerned is the whole milk and the resulting skim-milk.

Relative Weighted Market Value Method

The creameries are paying, at this time, 3.08 dollars for each hundred pounds of (3.5 per cent butterfat) manufacturing milk. A dairy plant manager stated that 1.28 dollars are paid for each per cent of butter fat found in whole milk, or 4.48 dollars for a hundred pounds of Grade A whole milk with 3.5 per cent butterfat, as assumed for this project. The government's guaranteed price is 3.06 dollars per hundred pounds of whole milk with 3.9 per cent butterfat. Certain co-op managers state that they are allowing ten cents (a part of the 3.08 dollars) extra for bulk milk purchases—this means that they are actually paying 2.98 dollars for non-bulk milk. The ten cents is an incentive cost for shifting to bulk sales. On the other hand, there is a twenty-five cents hauling charge paid by the producer. This charge is not considered in any of the calculations.

The cost of whole milk to Plant A is 3,080 dollars and 4,928 dollars daily for Plant B. The weighted relative market value, of either plant, is 69.47 per cent of this cost for the whole milk from which butter is processed; While 30.53 per cent of the raw variable resource input cost goes into powdered milk. When the daily manufacturing cost is added, the total daily cost of inputs is 3,551.84 dollars for Plant A and 5,500.79 dollars for Plant B. This means that each one hundred pounds of whole milk cost 3.55 dollars to Plant A and 3.44 dollars to Plant B, or eleven cents per hundred pounds less for the larger size plant.

The cost per pound of the finished product was .55458 for butter in Plant A and .54030 in Plant B. Expenses incurred in the production of one pound of dry-milk in Plant A was .14732 while in Plant B it was .1350---the cost benefit was .01232 in favor of the larger plant, under the weighted value method. These statistics are tabulated in Table XXXVI.

Departmental Transfer Value Method

The price paid for manufacturing whole milk, as stated in the previous section, remains the same. The primary difference is that the

TABLE XXXVI. COST OF BUTTER AND DRY-MILK PER POUND FOR PLANTS A AND B
(BASED ON RELATIVE MARKET VALUE WEIGHTED)

	Mfg. daily cost per pound	Mfg. daily cost	Cost of whole milk*	Per cent of the market value	Total daily cost	100 pounds of whole milk	Finished product per pound	Whole milk cost per pound	The finished products	Per 100 pounds whole milk costs
Plant A										
Butter	$ .05440	$232.71	$2,139.68	69.47	$2,372.39	$2.37	$ .55458	$ .50018	$4,277.81	$2.14
Dry milk	.02865	239.13	940.32	30.53	1,179.45	1.18	.14932	.11267	8,346.00	.94
Totals		$471.84	$3,080.00*	100%	$3,551.84	$3.55				$3.08
Plant B										
Butter	$.04012	$274.62	$3,423.48	69.47	$3,698.10	$2.31	$ .54030	$ .50018	$6,844.49	$2.14
Dry milk	.02233	298.17	1,504.52	30.53	1,802.69	1.13	.13500	.11267	13,353.00	.94
Totals		$572.79	$4,928.00	100%	$5,500.79	$3.44				$3.08

*Creameries pay 3.18 per hundred pounds for manufacturing milk. Hauling cost (25¢ per hundred weight) not included.

TABLE XXXVII. COST OF BUTTER AND DRY-MILK PER POUND FOR PLANTS A AND B
(BASED ON DEPARTMENTAL TRANSFER COST)

	Manufacturing Daily Cost	Pounds of products	Whole milk cost	Total cost	Mfg. cost per pound	Whole milk cost pound	Total cost per 100 pounds of whole milk	Finished product pound	Per 100 pounds whole milk cost
PLANT A									
Butter	$232.71	4,277.81	$2,327.64	$2560.35	$.05440	$ .54412	$2.56	$ .59852	$2.33
Dry milk	239.13	8,346.00	730.00	969.13	.02865	.08747	.97	.11612	.73
Buttermilk			22.36*						
Totals	(471.84)		(3,080.00)	(3,529.48)			(3.53)		(3.06)
PLANT B									
Butter	$274.62	6,844.49	$3,724.22	$3998.84	$.04012	$ .54412	$2.50	.58424	$2.33
Dry milk	298.17	13,353.00	1,168.00	1466.17	.02233	.08747	.92	.10980	.73
Buttermilk			35.78*						
Totals	(572.79)		(4,928.00)	(5465.01)			(3.42)		(3.06)

*Buttermilk transferred at .50 per hundred weight, and skim milk @ .80 per hundred weight.

These problems are grouped into the categories that follow:

A. Policies of Management

1. There is a very little provision for advertising and promotion.
2. Insurance is not assumed to be carried on finished and semi-finished products, nor on the raw resources input (whole milk and/or skim milk).
3. A rather large percentage (two per cent) is allowed for such production problems as waste, and the stickage of butter and/or cream to pipes and containers.
4. Maintenance is performed by the production staff and no provision is made in the budget for labor maintenance purposes. Projection of needs for repair parts would depend on durability of fixed inputs and the kind of upkeep received.
5. The cost of labor is lower in South Dakota than in some of the other dairy products manufacturing states. Generally, labor costs vary between regions.

B. Policies of the State and of the Insurance Companies

1. There is no special personnel employed for the maintenance and boiler operation. Some regions or states use special workers, while others do not. The reason is that some states have a boiler inspection department which requires the carrying of boiler insurance; and some of the insurance corporations require that a full-time person should be on the job while a boiler is in operation, even though such facilities are completely

automatic.

C. Accounting Problems

1. The period over which fixed resource inputs are depreciated is longer than is customary but shorter than that which is recommended by the Department of Internal Revenue. The Government suggests a life period for the fixed equipment of creameries that range from thirteen to twenty-five years, and as long as fifty years for the building. Many of the dairy products manufacturing firms spread their equipment depreciation over a period of from six to twelve years, others may not depreciate at all. For the building, the life range is assumed to be from twenty to thirty five years, by these entities.

2. The cost of utilities may vary between plants and/or regional location. The causal factor is important. The basic contractual relationship between involved entities gives rise to the accounting costs that will be recorded.

The Effect of Cost Distribution

The costing of whole milk to the two functional departments was performed by two methods previously explained. Results are equated with the market value of the finished products and recorded in Table XXXVIII. This compilation is in two parts. Part one is based on Table XXXVI and Part Two on Table XXXVII. The increase, based on the weighted relative market value of products, showed a positive change of 276.42 dollars for

TABLE XXXVIII. DAILY PROFIT BY PRODUCTS FOR PLANTS A AND B

PART 1. BASED ON TABLE XXXVI

Plants---Products	Total cost	Market value	Daily profit
PLANT A			
Butter	$2,372.39	$2,576.52	$204.13
Dry milk	1,179.45	1,132.55	-46.90
Total	(3,551.84)		(157.23)
PLANT B			
Butter	$ 3,698.10	4,122.44	$ 424.34
Dry milk	1,802.69	1,812.00	9.31
Total	(5,500.79)		(433.65)
PART 2. BASED ON TABLE XXXVII			
PLANT A			
Butter	$2,560.35	$2,576.52	$ 16.17
Dry milk	969.13	1,132.55	163.42
Total			(179.59)
PLANT B			
Butter	3,998.84	4,122.44	$123.60
Dry milk	1,466.17	1,812.00	345.83
Total			(469.43)

the larger size plant. Under this method, Plant A had a loss of 46.9 dollars in its drying operation. There was a gain of 9.31 dollars by Plant B for similar activities, however. All departments of operation showed a gain using the transfer method of costing. However, the profit from butter decreased from 204.13 to 16.17 dollars in Plant A when the costing method changed. There was an increase in gain from a loss of 46.90 to a gain of 163.42 dollars for the same plant in its drying area. The results were compatible with those found to exist where Plant B was involved.

Summarizing the results, the transfer method of costing the skim milk showed an increase of 22.36 dollars for Plant A, while the increase was 35.78 dollars in Plant B. An amount of 13.42 dollars of the increase in the B plant is due to the fundamental difference in the size of plant and not the method of synthesizing the costs to each plant. The remaining amount of 22.36 dollars is the cost of buttermilk. These figures show several interesting results. They are: (A) The extra profit accruing due to the use of departmental transfer accounting is equal to .0245 cents per hundred pounds of skim milk. (B) The market cost of whole milk that goes into butter processing is nineteen cents a hundred greater under the transfer method. But this same input resource which goes into dry milk cost twenty one cents less under the same method. Thus, 100 pounds of skim milk should cost 92 cents rather than the eighty cents transfer cost. However, there would be a loss in the drying operation. (C) Under the presently used system, the cost of a hundred pounds of skim milk could be 82.45 cents without a reduction of profit when the first considered method is employed. This is true for both plant models.

CHAPTER VII

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The Problem

Basic descriptive research of the dairy industry preceded the analysis of the manufacturing problems. The purpose was to locate the primary causes of the problems and ascertain some of the needs of the management in creameries.

The aggregate problems were found to be centered in (1) the availability and volume of supply to and for a particular creamery, (2) the changing nature of the methods of assembly, and (3) the fluctuations of demand for the various kinds of dairy products. This historical background led to a hypothesis.

Hypothesis

It was hypothesized that South Dakota creameries can operate at lower unit manufacturing cost by small plant mergers to increase volume so that labor, modern technology, and other inputs into the consolidated plants could be used more efficiently.

Objective and Scope

The primary purpose of the research was to test the hypothesis by providing data that could be used in decision making regarding the more profitable operation of dairy products manufacturing plants. In addition, economic information needed by dairy products manufacturing plants, that would enable the managers to adjust plant operations and procedures in order to lower processing costs, was to be developed.

There were four requirements that had to be fulfilled and then synthesized if the objectives were to be achieved. These requirements were:

(1) To ascertain the efficiency with which inputs could be synchronized into unified manufacturing processes—that is the economy with which fixed and variable inputs can be combined at a special scale of output.

(2) To determine the physical requirements and monetary costs to manufacture butter and non-fat milk powder at a stated quantity.

(3) To synthesize costs of the two models' butter and non-fat milk powder manufacturing plants.

(4) To formulate cost standards for each phase and function of operation at a more efficient level, as a basis for decision making, on whether the merger of butter and dry-milk manufacturing of present creameries is profitable.

Procedures

The method by which the objectives were accomplished was the development of two synthetic models that would allow for the individualized treatment of the factor inputs, permit an analysis of the economies of plant size and comparisons of inter-departmental operations.

The two models selected for development were called Model Plant A and Model Plant B. Plant A (the case plant) was based on the actual daily receipts of 100,000 pounds of whole milk from the area under consideration. The basis for the development of the second plant model, called Plant B, was the potential daily receipts of 160,000 pounds of whole milk from the same area.

Also, a part of the basic procedure was the selection of a case study area as the source of supply for the whole milk. The primary criterion in the selection of the case study area, was that the territory must be the actual assembly area of an existing plant.

The next step was to secure the technical assistance from persons in the field of dairy engineering and representatives of dairy equipment manufacturing firms.

Numerous assumptions were established to delimit the problem. Then consideration was given to aspects of butter and non-fat milk powder manufacturing. Included were the size and construction of the building; the quantity and specifications of equipment, labor inputs requirement; costs of labor, utilities, rents, interest, insurance and supplies; the activity time period required and the cost of each phase and operational function and the cost of the building and equipment.

The building was divided into three functional areas: evaporation, receiving-processing, and administrative services. The equipment layout was designed with the synchronization of productive sections as a primary objective. Costs of the building and equipment were computed on a daily input basis for both of the model plants. However, the daily building cost was the same for each of the two model plants, since both models employed identical buildings. Because the equipment was larger in the B plant, the cost in the non-service sections of the plant was relatively greater than that used in Plant A.

The input factors,other than raw materials, were divided into three groups to facilitate calculations and analysis. The groupings were (a) labor cost, (b) utilities, and (c) insurance, interest, taxes, maintenance cost, equipment depreciation and miscellaneous charges.

Computation of labor cost was predicated on work outlines or work schedules for each functional area. The working environment in South Dakota differs in many respects from that found in other mid-western states. The divergence contributed largely to the lower labor cost for a forty hour work week. The period of operation for the manufacturing processes was basically dependent on synchronizing the separators' output to the other pieces of equipment. Around their performance hinged all plant activities. This is evident in the work charts. The graphic presentation (work chart) showed the respective plants' work day to be eleven and twelve hours in length of time. During these periods of work activities,at the least,two persons are on duty together for seven days per week in each productive section. The normal work week was considered to be forty hours. Thus,the complete work chart for each kind of job to be performed, promoted security, reduced cost, facilitated rotation of employees and over all planning. The method of time study revealed that the larger model plant with a sixty per cent greater daily volume required an operation time period of only one hour more per activity day than the small model plant. Also, the managerial position could more easily be reduced to a supervisory function under the method of work schedule planning.

One group of variable inputs analysed consisted of elements such as electricity, oil, water and gas. Costs of this group were computed on a monthly basis, then reduced to daily inputs. Cost bases were either contracts in force or existing schedules of established charges. There were several different bases for the cost analysis of the factors inputs; the cost of electricity was related to the quantity consumed; cut and cut cost of oil depended on the season of the year, degree of competition with other products, the bargaining mood of the distributor, and the procured volume; and water and gas had relevance to quantity consumption. Engineering rules-of-thumb were used to ascertain the volume of the other inputs, which was in proportion to the assembled daily volume of raw resource input and the daily work activity time periods.

The input cost factors were divided into two groups, fixed and variable. Several of the factors in the variable group were considered to have both fixed and variable components' characteristics. All of the costs, groups not being considered, were reduced to a daily input cost basis for both model plants by functional areas. The method of computing the cost of each kind of input was recorded in detail.

The tax charges were based on the average assessed figure for South Dakota, but for the averaged mill rate it was necessary to rely on judgment, data and estimates. Information received from a tax assessor was to the effect that the existing mill rates would tend to increase due to the inflationary effect on real property prices and the need for more revenue. Also, once tax rates have been set on property they are seldom reduced regardless of changes in the book value of property.

Maintenance costs were also a judgment determination, since projection of their magnitude would rest on managerial policies which could not possibly be known in advance. In the case of equipment, the depreciation period employed was an assumed unweighted average between the suggestion of the internal revenue department and that which is actually used by many creameries, or fifteen years.

Findings

The methods employed in the procedures gave consideration to seventeen input factors. Of these, three were found to be "fixed" and the other fourteen "variable". Cost synthesis of the factors resulted in estimated manufacturing cost of finished products. It was recognized that actual costs might differ somewhat from the estimates for several reasons: (a) The policies of management differs widely. There are different ideas dealing with promotion, the extensiveness of insurance coverage, waste, projections of future expenses and labor costs. (b) The state-corporation relationship has an influence on costs. For example, a state's boiler inspector in conjunction with an insurance company requiring that certain workers be on duty at all times during the operation of boilers. (c) Accounting problems entail the selection of depreciation periods (or the life of the asset to be depreciated) and the method to be used. Also, there are the regional factors that are either conventional or contractual, which may have a great, but varying effect, such as the hourly rate for labor and the contractural cost of the utilities consumed.

The "best" costing method for the skim-milk is related to the cost per pound of the manufactured products in the competitive market, and to the beliefs of management about which product could and should carry the heaviest share of expenses. The relative weighted method resulted in a loss in the evaporating section of the smaller plant, while the similar area of the larger plant showed a gain. All of the manufacturing departments of both models showed improvement when the transfer method of costing was utilized. However, the increase was 35.78 dollars for the larger Plant B and 22.36 dollars per day for the smaller Plant A. These figures resulted from the transfer cost procedure. The difference of 13.42 dollars is due to the difference in the size of the plant.

The study revealed that skim-milk prices could be .0245 cents higher per hundred pounds without a loss under the presently used transfer plan. Under this plan of cost determination, butter processing costs more than it would using the other costing procedure.

Conclusions and Recommendations

The dairying industry should give closer attention to cost problems, particularly some that do not appear, on the surface, to be very significant. Also, the increasing importance of automation calls for constant awareness of the industry's position in the American economy.

Present plants in South Dakota are too small to take advantage of the economies of size and to operate, at highest efficiency, in the long run. This means that manufacturers of dairy products need to give more consideration to certain needs. Generally, they may be classified into three groups.

(1) Increase attention given to improving work hours and pay of the employees.

(2) The need for plants to grow larger and handle a larger volume to survive, through merger or new investment.

(3) The need for more cost-conscious managerial planning.

These moves may enable the organizations to increase prices paid to the producers of whole milk.

Limitation of Study

Both size models are believed to be relatively inefficient when related to the trend in industry; the capacities of many of the mid-western plants and the cost-capacities of automatic equipment used in the manufacturing processes of dairy products.

Before more efficient plants can be located in the area, a larger available volume of whole milk will be required. If, and when this occurs, new cost studies will be needed for larger type plants. It would be meaningless to undertake these now, in view of the rapid developments in technology which would render them obsolete before they became applicable.

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THE COST OF MANUFACTURING BUTTER AND NON-FAT MILK SOLIDS IN TWO MODEL PLANTS IN SOUTH DAKOTA

Abstract

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This research was undertaken as a part of the North Central regional studies regarding management policies and decision-making in dairy processing plants. The data developed in this study should have an influence on the management policies and decisions which are made by the management of these plants.

The cost of manufacturing butter and non-fat milk solids powder was developed for two different sizes of plants. Model Plant A was designed to receive and process a volume of whole milk receipts equivalent to the dairy receipts of whole milk which is presently being received by an actual operating plant in eastern South Dakota (called the case plant). The second and larger plant, Model Plant B, was designed to receive and process a daily volume equivalent to that which would be received by the case plant if this case plant received all of the whole milk that is presently being produced in the case plant's procurement area. Grade A milk production within the area was not included.

The costs of the various inputs of each plant were calculated by manufacturing phases and areas of operation. Because of the nature of the equipment used in dairy manufacturing plants, it was possible to use the same size building for both models. But different sizes and numbers of the items of equipment were employed in the production

activities. Because of this, the cost of some of the inputs were constant for both models, while the costs of other inputs increased for the larger plant, Model B. The total cost per unit of the outputs decreased for the larger size plant.

There were two costing methods used to charge the skim-milk to the evaporation-drying area. Skim milk was considered as a by-product in one method and as a joint product in the other method. The methods were (1) the relative market value of the finished products weighted and (2) the departmental transfer cost, which is used by the plants in South Dakota---this is the market value of the skim-milk.

The empirical data revealed that because of the nature of the variable inputs, some of which were "mixed," a unit cost curve for a plant would not give accurate cost information for policy making as the volume of resource input fluctuates. Further, the research revealed the extent to which the latest equipment (some of which is not presently being used in South Dakota) can be synchronized between functional areas. Also, the programming of labor to promote efficiency during each activity-time-function-period is shown.